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VOL. CXLII.—No. 3697] LONDON: FRIDAY EVENING, NOVEMBER 19, 1926 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. 144 Pairs of DISC WHEELS and AXLES.
2. 33 Sets of MATERIALS for BODIES of BOGIE CARRIAGES.
Tenders due on the 7th December, 1926.
Specifications and forms of Tender obtainable from the above, at a fee of 5s. per set, which will not be returned. 4023

War Department. TENDERS are INVITED for the PURCHASE of a quantity of serviceable War Department MACHINERY, consisting of steam, gas, and petrol engines and electric generators, together with switchboards, voltmeters, ammeters and other electrical fittings. The stores are lying at the R.A.O.C. Depot, Weedon, Northamptonshire, and conveniently situated for loading on railway trucks or canal barges.
Application for forms of Tender, conditions of sale, and permission to view should be made to the OFFICER i/c R.E. STORES, Berechurch-road, Colchester, on or before 7th December, 1926. Delivery of Tenders will be required by Twelve Noon on 15th December, 1926, as stated on form of Tender. 3983

Architectural Draughtsman REQUIRED by the GOVERNMENT of KENYA COLONY for a tour of 30 months' service. Salary £500 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, should have taken an honours course at some approved Technical College with success. Should have a thorough knowledge of building construction and preferably have had experience in the design of municipal and domestic architecture. Should be accomplished draughtsman with knowledge of perspective drawing.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15024. 4035

Assistant Engineers (9) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary, £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E., or possess a degree in Civil Engineering recognised by the Institution as exempting from parts "A" and "B" of the examination. They must have had proper technical training, and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other Civil Engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications, and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 3973

Civil Engineers (2) REQUIRED for the PUBLIC WORKS DEPARTMENT of NORTHERN RHODESIA for a tour of 20 to 30 months' service, with possible extension. Free quarters and passages and liberal leave on full salary. Outfit allowance of £50 on first appointment. Candidates, age 23 to 35, unmarried, should have passed A.M.I.C.E. examination or possess a degree exempting them from Parts A and B. They must have had practical experience in construction of Roads, Buildings, Bridges, and Drainage Work. Preference will be given to candidates holding the A.M.I.C.E. diploma. Salary £500 a year, rising by annual increments of £25 to £800 a year, or £400 a year, rising by annual increments of £25 to £800 a year according to qualifications.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14955. 3985

Required for Service under the GOVERNMENT of INDIA, ASSISTANT FOREMAN for the HARNESS and SADDLERY FACTORY, CAWNPORE (APPOINTMENT 84). Must have served a period of not less than five years in a general engineering workshop, preferably a jobbing repair shop. Preference will be given to a man who has had experience in working on Drop Forgings of a small nature, such as used in harness work, and comparatively rough repetition work. Candidates must have passed second year preliminary examination in Mechanical Engineering at a recognised technical college, be competent to inspect metal components of harness manufacture, and be able to make and read drawings. Age between 25 and 35 years. Good prospects for suitable man. Salary Rs. 450-15-510 per calendar month, with prospects of further increases.
TERMS.—Agreement for five years in the first instance. Free second-class passage to India and return passage on satisfactory termination of services. Free quarters. Medical examination.
Further particulars and forms of application should be obtained from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications, 4th December, 1926. 3976

The High Commissioner FOR INDIA is prepared to receive APPLICATIONS for SIX APPOINTMENTS as CIVIL ENGINEERS, Burma Public Works Department. The appointments will be made temporarily on agreement for five years in the first instance, with the prospect, subject to satisfactory service, of permanent employment thereafter.
Candidates must be between 22 and 24 years of age and unmarried. They must have either (1) obtained a recognised University Degree; (2) passed Sections A and B of the A.M.I.C.E. examination; or (3) passed the Associateship in Civil Engineering of the City and Guilds Institute (Imperial College of Science and Technology); or obtained such other Diploma or distinction in Engineering as may be considered acceptable. In addition, at least one full year's practical experience of Civil Engineering under a qualified civil engineer is required.
The commencing pay will be Rs. 375 a month, plus overseas pay Rs. 150 a month, rising by annual increments to Rs. 525 a month plus overseas pay £15 a month for the fifth year. Overseas pay is admissible only to officers of non-Asiatic domicile.
Further particulars and forms of application should be obtained from the SECRETARY to the High Commissioner for India, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications, 10th December, 1926. 4033

The Engineer

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PUBLIC NOTICES

Indian State Railways. ELECTRICAL ENGINEER.
An ELECTRICAL ENGINEER is REQUIRED for service on INDIAN STATE RAILWAYS, who must be capable of taking charge of an important district. Age 33 to 40 years.
QUALIFICATIONS.—Must be a Chartered Electrical Engineer, with sound theoretical training, and must have had good experience of the operation of steam and oil engine-driven plant for generation and distribution of power. He must be competent to design and lay out complete power schemes.
SALARY.—Rupees 975 plus £30 overseas pay up to Rs. 1075 plus £30 overseas pay a month, rising in accordance with the rules in force to Rs. 1375 plus £30 overseas pay a month. (Overseas pay is admissible only to an officer of non-Asiatic domicile).
LEAVE, PROVIDENT FUND AND GRATUITY in accordance with the rules applicable to officers of the Indian State Railways. AGREEMENT for three years in the first instance, but service to be extensible beyond that period with the consent of both parties concerned. A free first-class passage to India will be provided.
The selected candidate will be required to pass a strict medical examination before appointment.
Applications may be made by letter only and should give in chronological order (with dates) a record of candidate's career, containing particulars of general and technical education, honours, degrees, &c., details of practical training, and experience, with names of firms and previous employers. COPIES ONLY of testimonials should be sent. Such applications must be received by the undersigned not later than 7th December, 1926.
RENDEL, PALMER & TRITTON,
4022 12/14, Dartmouth-street, London, S.W. 1.

Brighton Intercepting and OUTFALL SEWERS BOARD.
RECONSTRUCTION OF SEWER OUTFALL AND CONSTRUCTION OF SEA WALL.
TENDERS are INVITED by the above Board for the RECONSTRUCTION of the existing OUTFALL at Portobello, together with SEA WALL and other incidental Works.
The works include the laying of two lines of 60in. diameter Cast Iron Pipes, with an approximate length of 640 yards, and a Sea Wall about 150 yards in length.
Plans may be seen and general conditions, specification, quantities and form of Tender may be obtained at the office of the Engineer to the Board, Mr. David Edwards, M. Inst. C.E., Town Hall, Brighton.
A deposit of Ten Guineas will be required, which will be returned on the receipt of a bona fide Tender.
Sealed Tenders, endorsed "Contract for Sewer Outfall and Sea Wall," to be delivered at the office of the undersigned on or before November 30th, 1926.
The Board does not bind itself to accept the lowest or any Tender.
(Signed) JAS. H. ROTHWELL, Clerk to the Board.
Town Hall, Brighton. 3940

PUBLIC NOTICES

In the High Court of Justice, Chancery Division, Mr. Justice Tomlin. 1926 P. No. 1938

IN THE MATTER of Letters Patent No. 5775 of 1911 bearing date the 8th day of March 1911 granted to Samuel Rowland Parkes in respect of Improvements in Clips for Labels and the like
and
IN THE MATTER of The Patents and Designs Acts 1907 and 1919.

Notice is Hereby Given that SAMUEL ROWLAND PARKES of Pretoria Works, Willenhall in the County of Stafford, Lock Manufacturer has by Originating Summons dated the 23rd day of September 1926 applied for an Order that notwithstanding the six months referred to in section 18 of the above-named Patents and Designs Act 1907 have commenced to run the time within which such application might be made might be extended, and that the above-mentioned Letters Patent may be extended for a further period of five years or such other time as the Court shall think fit. And Notice is Hereby Given that the said Originating Summons has been adjourned into Court before Mr. Justice Tomlin, at the Royal Courts of Justice, Strand, London on Tuesday the 14th day of December, 1926, when His Lordship will fix the date of hearing of the said Summons. And Notice is Hereby Given, that any person desirous of being heard in opposition to the said Summons must at least seven days before the said 14th day of December 1926 lodge notice of such opposition at the Chambers of the Judge, Room No. 317, Royal Courts of Justice, Strand London and serve a copy thereof upon the Applicant.
Dated this 15th day of November 1926.
NICHOLLS and CO.,
17, Farringdon-street, London, E.C. 4.
Solicitors for the Applicant, upon whom all documents requiring service may be served.
4018

Sudan Government, Education DEPARTMENT.
A LECTURER in MATHEMATICS is REQUIRED for the Gordon College, Khartoum. Candidates should be under 30 years of age, preferably unmarried and should possess a degree of some recognised University, either in Science or in Arts, with some distinction in Mathematics. Commencing salary £E480 per annum (£E1 equals £1 0s. 6d. approximately), the appointment to be in the first instance for two years, but thereafter will be permanent and pensionable if the candidate is found suitable. Three months' leave per annum on full salary with assisted passage allowance. Strict medical examination.—Full particulars can be obtained from, and applications should be lodged with, the CONTROLLER, Sudan Government London Office, Wellington House, Buckingham-gate, S.W. 1. Envelopes to be marked "Lecturer." 3997

PUBLIC NOTICES

Armstrong College, NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.SC. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to
THE REGISTRAR,
Armstrong College,
3998 Newcastle-upon-Tyne.

Fylde Water Board. AQUEDUCT NO. 5 CONTRACT.
DISPOSAL OF PLANT.
The Fylde Water Board are prepared to receive OFFERS for all or any of the CONTRACTORS' PLANT and MATERIAL lying at their Depot at Longridge, near Preston.
All plant, the main items of which are set out below, is in good condition and running order and open to inspection.
A full list of the plant and material for disposal and permission to view can be obtained from the undersigned.
Offers, marked "Aqueduct No. 5 Plant," should be received by me not later than first post Tuesday, December 7th, 1926.
GEO. F. ATKINSON,
Engineer.
Head Office,
Sefton-street, Blackpool.

2 Austin PETROL-DRIVEN TRENCHING MACHINES, each capable of digging a trench up to 4ft. wide by 8ft. deep.
2 Austin CRANE TYPE TRENCH FILLERS, driven by 30 H.P. Petrol Engine mounted on caterpillars.
3 AIR COMPRESSORS, maker Broom and Wade, Dorman Engines, capacity 300 cu. ft. free air per minute.
2 Johnson TAMPING MACHINES, driven by 3 H.P. Petter Engine.
1 Hamworthy PETROL-DRIVEN WINCH.
2 PETROL-DRIVEN CENTRIFUGAL PUMPS, mounted on road wheels, 4in. suction, 3in. delivery, capacity 230 gallons per minute.
One 2-Ton HAND DERRICK CRANE.
One 40 H.P. "Simplex" PETROL LOCOMOTIVE, 2ft. gauge.
2850 Yards PORTABLE RAILWAY TRACK, 2ft. gauge.
6 SETS POINTS and CROSSINGS.
15,000 Yards F.B. RAILS, chiefly 22/24 lb.
7000 WOOD SLEEPERS, 4ft. long.
PNEUMATIC TOOLS, DIAPHRAGM PUMPS, JACKS, BARROWS, SHOVELS, HUTS, CABINS, TOOL BOXES, CHAIN BLOCKS, SHEAR LEGS, GANTRIES, TIMBER, ROPE BLOCKS, BARS, &c.
3957

Royal State Railways of Siam. NOTICE.
SEALED TENDERS for the SUPPLY of WHEELS and AXLES, B.E. 2470, will be received by the ADMINISTRATION of the ROYAL STATE RAILWAYS of SIAM, Bangkok, until Fourteen o'clock on the 1st March, 1927, at which place and hour the Tenders will be publicly opened and read.
Blank Tender forms, general conditions, specifications and drawings may be obtained from Messrs. C. P. Sandberg, 40, Grosvenor-gardens, London, S.W. 1, upon payment of £1 per set, which sum will not be refunded.
Right is reserved to reject any or all Tenders and to accept any Tender, which is to the best interests of the Royal State Railways of Siam. 4005

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PUBLIC NOTICES

City of Leicester.

STORM WATER AND SEWAGE DISPOSAL WORKS.

SALE OF STEAM PUMPING PLANT AT THE BEAUMONT LEYS SEWAGE FARM.

The Corporation have a quantity of STEAM PUMPING PLANT for which they are prepared to receive TENDERS for the WHOLE or any PART.

The plant includes:—No. 3, 20in. Centrifugal Pumps, No. 3, 5in. Centrifugal Pumps; No. 1, 8in. Centrifugal Pump and Fittings, &c.

Three Lancashire Boilers, with Economiser.

The plant can be inspected at Beaumont Leys Effluent Pumping Station by arrangement with the City Surveyor's Department, and offers should be delivered at the Town Hall, addressed to the Chairman of the Sewage Works and Farms Committee, endorsed "Tender for Steam Pumping Plant," NOT LATER THAN WEDNESDAY, DECEMBER 8th, 1926.

H. A. FRITCHARD,
Town Clerk.

Town Hall, Leicester. 4012

South Indian Railway Company,

LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

1. COPPER TUBES, BRASS SHEETS, &c.
2. COPPER RODS and INGOTS.
3. METALS.
4. PIG IRON.
5. CAST IRON PIPES.
6. WIRE ROPE.
7. TWIST DRILLS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Copper Tubes, Brass Sheets, &c.," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 3rd December, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of specifications Nos. 1 to 4, and 2s. 6d. for each copy of specifications Nos. 5 to 7.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1,
16th November, 1926. 4021

Stroud Urban District Council.

SALE OF FIRE ENGINE.

The Council are prepared to receive TENDERS for the PURCHASE of a Merryweather Horse-drawn STEAM FIRE ENGINE and ACCESSORIES.

The engine is capable of pumping 300 gals. per minute at a pressure of 100 lb. per square inch, is in a sound condition, and same may be examined, or, by arrangement, its capabilities tested, at Stroud.

Sealed Tenders, endorsed "Fire Engine," to be delivered to me at my office, No. 1, Lansdown, Stroud, not later than 30th November, 1926.

(Signed) E. NORTHAM WITCHELL,
Clerk of the Council.

4031

Stourbridge and District

WATER BOARD.

TO WELL BORERS.

The above Board invite TENDERS for the SINKING of a BORE varying from 28in. to 20in. diameter at Mill Meadow Pumping Station, Stourbridge, to an approximate depth of 250ft. from surface of ground.

Detail drawing may be seen and copy of the specification, bill of quantities, conditions and form of Tender obtained from the Consulting Engineer, Mr. W. Fiddian, 13, Church-street, Stourbridge, on and after Thursday, the 18th inst., on payment of a deposit of Two Guineas, to be returned on receipt of a bona fide Tender with the schedule and quantities duly filled in.

Sealed Tenders, endorsed "Tender for Boring," to be sent to the undersigned not later than Noon on Monday, the 29th inst.

The Board do not bind themselves to accept the lowest or any Tender.

F. P. EVERS,
Clerk to the Board.

15, Hagley-road, Stourbridge,
November 15th, 1926. 3989

The Bengal and North-Western

RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

FIVE LOCOMOTIVE TENDERS for "F" Class Engines,

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned, and marked "Tender for Locomotive Tenders," with name of firm tendering, to be lodged not later than Noon on the 13th day of December, 1926.

For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
F. A. WAKE,
for Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2, 17/11/1926. 4020

Burma Railways.

2 ASSISTANT ENGINEERS.

The Directors are prepared to receive APPLICATION (by letter only) from properly qualified candidates for APPOINTMENT as ASSISTANT ENGINEERS in Burma.

Applicants must be single, between 22 and 28 years of age, and be active and of good physique. They must have had at least three years' training in a recognised Engineering College and hold an Engineering Degree or have passed the A.M. Inst. C.E. Examination, and have had practical experience of not less than one year.

SALARY.—Rs. 550 to commence, rising by annual increments of Rs. 50 to Rs. 1100 per calendar month.

TERMS.—A three years' agreement in the first instance, with first-class free passage to Burma and home again on satisfactory termination of services.

The selected candidate will be required to pass a strict medical examination by the Company's Consulting Physician before final appointment.

Applications, giving all the particulars called for above and showing candidate's career in chronological order (with dates), should be addressed to the undersigned not later than Monday, 22nd November, 1926.

SECRETARY,
199, Gresham House, Old Broad-street, E.C. 2.
3975

City of Bradford.

ELECTRICITY DEPARTMENT.

DEPUTY CITY ELECTRICAL ENGINEER.

APPLICATIONS are INVITED for the POST of DEPUTY CITY ELECTRICAL ENGINEER to the Bradford Corporation.

The person appointed is required to assist the City Electrical Engineer and Manager in all engineering matters, but principally in connection with the generation and distribution of electrical energy.

Applicants must have received a sound technical education, and have practical knowledge of the design and operation of electrical generating and converting plant and transmission and distributing systems.

The salary attached to the post will be from £750 to £1000 per annum, and candidates are requested, in making application, to state the salary required.

The successful candidate will be required to devote his whole time to the duties of the office, and to reside within the city.

Canvassing members of the Council (either directly or indirectly) will be a disqualification.

Lists of duties and forms on which applications are to be made may be obtained from Mr. Thomas Roles, City Electrical Engineer and Manager, 45 to 53, Sunbridge-road, Bradford.

Applications, endorsed "Deputy City Electrical Engineer," accompanied by COPIES of not more than three testimonials (which will not be returned), to be sent in time to reach me not later than the first post on Tuesday, the 30th November, 1926.

N. L. FLEMING, Town Clerk.

Town Hall, Bradford,
6th November, 1926. 3930

PUBLIC NOTICES

Great Southern Railways.

A STEEL WORK DRAUGHTSMAN and FOUR JUNIOR CIVIL ENGINEERING DRAUGHTSMEN are REQUIRED by the GREAT SOUTHERN RAILWAYS, IRELAND.

Applicants for the former vacancy should have had considerable experience in the design of Bridges and Roofs, either in a Railway Engineer's Office or in a Bridge Builder's Office. Commencing salary £300 per annum.

Four Junior Civil Engineering Draughtsmen are required who should not be more than 25 years of age and who need not have had previous experience, if they have had a training in a School of Civil Engineering. Commencing salary £150 per annum.

Applicants for any of these vacancies should state age and give particulars of training and experience, and send not more than two copies of recent testimonials.

Applications should be posted so as to reach the undersigned not later than 10 a.m. on 4th proximo.

C. E. RILEY, Secretary.

Kingsbridge Station, Dublin,
15th November, 1926. 3990

Temporary Junior Civil Engineering Assistant.

Salary at the rate of £200 to £240, according to qualifications. The appointment may be of long duration. No testimonials or specimens to be sent in the first instance.—Apply to the CITY ENGINEER, Hull. 3984

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Well-educated ASSISTANT ENGINEER for Structural and General Engineering Works under British management in India, preferably University engineering training and A.M.I.C.E.; must be good organiser and have had thorough business and technical training and practical experience. Age 30 to 35.—Address, stating age, qualifications, experience and salary expected, P2407, The Engineer Office. P2407 A

WANTED by Firm of Commercial Motor Vehicle Manufacturers, ASSISTANT to CHIEF ENGINEER. Must have had first-class technical education and works training and be conversant with latest commercial vehicle design. Good salary to right man. Applications (which will be treated as confidential) must state age, training, experience, and when at liberty.—Apply by letter only to "A. C. E.," Karrier Motors, Ltd., Karrier Works, Huddersfield. 4027 A

WANTED, CHEMICAL ENGINEERING DESIGNER by Engineering Works in the North-West of England. Must be thoroughly conversant with Chemical Engineering generally and especially Sulphuric Acid, Alkali, and Artificial Silk Plant. Age not over 45.

Send full personal particulars and experience, stating salary required.

Address, 4029, The Engineer Office. 4029 A

WANTED, SALESMAN, to Travel Whole of England for engineering speciality saleable amongst builders, ironmongers and private houses. Mechanical experience desirable.—Address, stating age, whether single, qualifications and experience, 3995, The Engineer Office. 3995 A

ASSISTANT to DIRECTORS WANTED by Firm of Commercial Motor Vehicle Manufacturers. Must have had first-class technical education, possess sound workshop experience, be familiar with sources of supply and prices of raw materials and finished parts, and have had experience of stores control systems. Applications (which will be treated as confidential) must state age, training, experience, salary required and when at liberty.—Apply by letter only to "T. A. D.," Karrier Motors, Ltd., Karrier Works, Huddersfield. 4026 A

INTELLIGENT YOUNG MAN with Ideas on publicity WANTED for Catalogues, Spare Parts Lists, &c. Must be capable of taking charge of drawing-office in absence of chief.—Address, 4002, The Engineer Office. 4002 A

REQUIRED by Firm in the West of England, ENGINEER with testing and research experience of Solid Injection Oil Engines. Must possess practical and technical knowledge, be quick to recognise symptoms, analyse and get results. Experience Testing Aero-engines or High-speed Engines would be an advantage.—Address, giving full particulars of experience and salary required, 3991, The Engineer Office. 3991 A

REQUIRED, GENERAL MANAGER for a large Electrical Power Company in a British Colony, having both Hydro-electric and Steam Stations, who should be a qualified Electrical Engineer with considerable experience in the Handling of the Commercial Side of big Electrical Supply Undertakings. Applicants must be able to negotiate with Government Departments and, if necessary, with consumers. The first engagement will be for a period of three years. Free residence and first-class passage out and home will be provided. Generous salary will be paid to the right man.—Applications giving full particulars as to age, education, training and subsequent experience and salary required, together with copies of testimonials, which will be treated in strictest confidence, to be sent addressed M. 3963, The Engineer Office. 3962 A

THE MANUFACTURERS of a Well-known CUTTING METAL with plant in England REQUIRE the SERVICES of a thoroughly qualified RESEARCH and SALES ENGINEER, capable of developing the market for the alloy, which possesses remarkable properties.

Applicant must be fully qualified as a Metallurgical Engineer and possessed of initiative and ambition to eventually assume full charge of the company's operations in Europe. This is an excellent opportunity for a young man with the requisite ability, personality and qualifications.

Address, 4006, The Engineer Office. 4006 A

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, REQUIRE the SERVICES of a FOUNDRY WORKS MANAGER.—Apply in writing, giving age and full particulars of experience, to the FOUNDRY GENERAL MANAGER, Stanton Ironworks Company, Ltd., near Nottingham. 4025 A

WANTED AT ONCE, JUNIOR DRAUGHTSMAN for Small Engineering Shop in East London, capable of extracting quantities and making detailed drawings from general arrangements for rapid production purposes. Quick intelligence for assisting works foreman necessary.—Address, stating salary required, 4034, The Engineer Office. 4034 A

WANTED, Capable and Reliable DRAUGHTSMAN, preferably experienced in Macadam Quarry Plant.—Address full particulars, P2459, The Engineer Office. P2459 A

WANTED, DRAUGHTSMAN, Experienced in Pumping Machinery, with special knowledge of Turbine and Centrifugal Pumps. State salary required and experience, with names of previous employers (which will be treated in strict confidence).—Address, 3986, The Engineer Office. 3986 A

WANTED, Good MECHANICAL DRAUGHTSMAN, experienced in Cement, Crushing and Grinding Machinery; one used to preparing complete Lay-out Schemes and with a knowledge of Structural Steelwork preferred. State particulars of experience, age and salary expected.—Address, 3983, The Engineer Office. 3983 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN (CHIEF) for Structural Engineer's Office, London; must be expert designer of Light Steel Building and possess initiative. Only men who have been thoroughly trained in light structural engineering need apply. State age, experience, where acquired, salary, and when free.—Address, 4036, The Engineer Office. 4036 A

DRAUGHTSMAN REQUIRED for Bridge Engineers' and Contractors' Office; must be accurate, quick, have knowledge of Design and experience of Detailing Bridge Steelwork and Foundations.—Address, giving full particulars, experience, age, and salary required, 4030, The Engineer Office. 4030 A

DRAUGHTSMEN REQUIRED, Preferably Experienced in Aircraft Engine Work.—Apply, stating age, experience, and salary required, to BRISTOL AEROPLANE CO., Ltd., Filton House, Bristol. 4007 A

LOCOMOTIVE DRAUGHTSMAN REQUIRED; must be conversant with Locomotive Design in general and in particular have had experience in the Design of Cylinders, Valve Chests, and be thoroughly conversant with Valve Motion, both in design and construction. Only experienced, reliable applicants will be considered.—Address, giving full particulars of qualifications, age, and salary required, 4014, The Engineer Office. 4014 A

REQUIRED, the SERVICES of a First-class MECHANICAL DRAUGHTSMAN. Must be thoroughly reliable and have good general experience. Permanency to suitable man.—Apply by letter to WORKS ENGINEER, British Reinforced Concrete Engineering Co., Ltd., Stafford. 3999 A

YOUNG DRAUGHTSMAN REQUIRED in London for Timber Constructional Work.—Address fully, details of experience, age, and wages required, P2479, The Engineer Office. P2479 A

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GUARDIAN WISHES to APPRENTICE well-educated YOUTH with well-established Firm of Consulting Engineers, London district. Premium if necessary.—Address, P2471, The Engineer Office. P2471 B

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WANTED, Good SECOND-HAND LANCASHIRE BOILER, about 28ft. long and 7ft. diameter; must stand 120 lb. pressure and be complete with fire-boxes, boiler seatings, steam gauge, safety valves.—Kindly say where same can be inspected and lowest cash price to WHITCHURCH BUILDING SUPPLY CO., Talbot-street, Whitchurch, Salop. P2487 F

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WORKS FOR SALE, Within One Mile of Centre of City. Suitable for Engineering and other trades, also WAREHOUSING. Close to Railway Station. Industrial district. Frontage to Barge Canal. Substantial buildings, 210,000 sq. feet floor area.

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The land is excellently situated for erection of works or factory requiring a large area.

Further particulars from Mr. A. E. PERCY, Priory-street, Dudley, Chartered Accountant, or Mr. E. BOSLEY, 120, Colmore-row, Birmingham, Chartered Accountant. 4024 L

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SUBSTANTIAL MODERN BUILDINGS, Mainly one floor, roof lighted. Constructed for heavy manufacturing reinforced concrete floors, internal transport. Electric light and power. All L.C.C. requirements Covered floor area exceeds

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Also Club House, 8 Workmen's Cottages. Space for extensive development. Total area 5 acres 13 poles. Freehold. Price £60,000, including fittings.—Sole Agents, TRYTHALL and McGAHEY, 69, Fife-road, Kingston-on-Thames. 4004 L

For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The New Broadcasting Wave Lengths.

THE object of the revised broadcasting wave lengths, which were put into operation on Sunday, November 14th, is to clear the ether, make present-day broadcasting in Europe more successful by minimising interference, and make way for the rapid developments that are anticipated in the future. Almost all the wave lengths in Great Britain have been altered, thus necessitating a change in the tuning of receiving sets to correspond with the changed conditions. Whilst the new scheme has been introduced for the general good of the public, some owners of receiving sets have probably found that their choice of programmes is more restricted than before. Listeners have, however, been reminded that it will be a little time before the change over can be satisfactorily achieved, and they have been requested to withhold any criticisms they may be inclined to put forward for at least a fortnight. The wave length of the London broadcasting station is practically unaltered, and apparently no complaints have been received concerning that station. As regards continental stations, the new wave lengths appear to have resulted in considerable improvement. Many amateurs who previously found difficulty in separating those stations, which have hitherto been working on similar wave lengths, are now able to tune them in with comparative ease and interference has been considerably minimised.

The Late Mr. W. W. Denholm.

IT is with regret that we have to record the death of Mr. Walter W. Denholm, the shipyard manager of Workman, Clark and Co., Ltd., which took place at Belfast, after a protracted illness, on Thursday, November 11th. Mr. Denholm was widely known, both in Belfast and also on the Clyde, and his loss will be keenly felt. It was at Glasgow that he received his education, where, after an outstanding scholastic career, he was apprenticed to the shipbuilding firm of D. and W. Henderson and Co., Ltd., of Meadowside. On completing his term of apprenticeship, Mr. Denholm was engaged for some time with the Alloa firm of Mackey Bros., and later he joined William Denny and Brothers, Ltd., at Dumbarton. In the year 1911 his first connection with Belfast began, when he entered the ship drawing-office of Workman, Clark and Co., Ltd. He possessed unusual abilities, which were not slow to be recognised, and at an early date he became the assistant manager and later the manager of the firm's North Yard. Last year he was appointed to be the manager of both the North and the South Shipbuilding Yards. Mr. Denholm was a member of the Institution of Naval Architects and of the Institution of Engineers and Shipbuilders in Scotland.

Electricity and Industry.

IN an address recently delivered before the Scottish centre of the Institution of Electrical Engineers, the chairman, Mr. Wilfred L. Winning, dealt with "Standardisation and Quantity Production of Electrical Apparatus." The condition of the electrical industry, he said, had been a comparatively happy one during the lean years that followed the boom period. The so-called luxury trades called for the electrification of their factories and the domestic load increased enormously. In the home electricity had become a necessity and the supporters of gas had practically given up the fight so far as street, house, and shop lighting was concerned. In manufacture the collaboration of the designer and production engineer had resulted in standardisation and quantity production, to the benefit of the buyer and the encouragement of the trade. The task of the British manufacturer was to improve production and lower prices, not only to meet foreign competition in their own line, but to help other industries to do so in theirs.

Naval Shipbuilding Contracts.

ALTHOUGH a considerable number of naval contracts are due to be placed under the Navy Estimates for the present financial year, only two appear to have been awarded so far. Palmer's Shipbuilding and Iron Company, Ltd., of Jarrow, has secured the order for one cruiser, and there are hopes that private yards will also be called upon to build the two other vessels of this type for which the Estimates provide. Vickers Ltd. have received the contract for a submarine depôt ship of large dimensions, to be propelled by Diesel machinery of the M.A.N. type. Orders still remain to be placed for two cruisers of 10,000 and 8000 tons respectively; six submarines of the "O" type, probably of 1345 tons; one repair ship and four motor launches. As Portsmouth and Devonport each has a cruiser on the stocks it is not expected that they will share in this year's programme, but the slip at Chatham has been vacant since the launch of the Kent in March, and local interests are doing their best to secure a new cruiser for that yard. It is considered probable that one or more of the six submarines will be built at Chatham, where there are special facilities for such work, but the majority will almost certainly be ordered from private yards in the North. Vickers are already building two 1400-ton submarines for the Australian Navy. When this year's contracts have been awarded the following vessels will be under construction or completing afloat:—Thirteen cruisers of 10,000 tons, one cruiser of 8000 tons, eight submarines, four gunboats, four motor launches, one submarine depôt ship, one repair ship, and a floating dock.

America's First "Treaty" Cruiser.

ALTHOUGH the first two American cruisers of the 10,000-ton "Washington Treaty" class were authorised last year, the keel of the first ship, Pensacola, was not laid down till October 27th of this year, the delay being due, it is understood, to important modifications in the original design. A sister ship, Salt Lake City, is to be begun at an early date, and six further vessels have been authorised. The United States Navy Department has published the salient details of the Pensacola, which is under construction at the Brooklyn Navy Yard. She will be 585ft. in length, 66ft. in breadth, and draw 19ft. at normal load. When equipped for sea the "standard" displacement of 10,000 tons, which excludes fuel and feed water, will be exceeded by about 1500 tons. The most striking feature of the ship is her relatively tremendous armament. She is to carry ten 8in. 55-calibre guns, probably mounted in two triple and two double turrets; four of the new 5in. anti-aircraft guns, and six torpedo tubes. In view of the great weight of this armament, protective plating has had to be reduced to a minimum, and with the exception of light steel decks over vital parts the ship will be destitute of armour. She is therefore at once the most heavily armed and the most vulnerable of the cruisers which have so far been designed in accordance with Treaty regulations. The designed speed is 33 knots, and it is unofficially reported that the boilers will generate steam at a pressure of 700 lb.

The Whitworth Scholarship Awards.

THE results of the competition for the Whitworth Senior Scholarships and Whitworth Scholarships, 1926, were issued by the Board of Education this week. As on former occasions, the awards have been made in overwhelming preponderance to apprentices at the Royal Dockyards. There were ten competitors for Senior Scholarships of an annual value of £250, tenable for two years. Two awards were made, one to a Bradford electrical engineer apprentice and the other to a Wallsend draughtsman. Seventy competitors entered for the scholarships valued at £125 per year for three years. Seven awards were made, three to Portsmouth Dockyard apprentices, two to apprentices at Devonport Dockyard, one to a Swindon and one to a Manchester apprentice. Whitworth prizes of £10 each were awarded to twenty-five unsuccessful competitors for scholarships. Of these prizes twenty-one went to competitors from Chatham, Portsmouth, and Devonport Dockyards, one to a Woolwich Arsenal apprentice, two to apprentices at Horwich, and one to a Sheffield apprentice. The actual monetary distribution, it will be observed, works out at £2095 to competitors from Government establishments and £1780 to competitors from all the rest of the country.

Recent Shipbuilding Orders.

IF an early settlement of the coal dispute permits a quick resumption of normal supplies of home-produced ship plates and sections, there seems promise of marked activity in more than one shipbuilding centre, for during the last ten days some noteworthy orders have been placed. Last week the King Line, Ltd., of London, signed a contract with Harland and Wolff, Ld., of Belfast, for the construction of nine motor cargo vessels, each of about 7800 tons deadweight carrying capacity. The ships will be fitted with the firm's marine oil engines and are to be laid down in the South Yard at Belfast. Harland and Wolff, Ltd., have also received orders for four twin-screw oil tankers of 2390 gross tons, designed for shallow-draught working, which will be built to the order of Andrew Weir and Co., of London. In Scotland the Caledon Shipbuilding and Engineering Company, Ltd., at Dundee, has recently received orders for ships aggregating some £500,000, the building of which is conditional on a speedy settlement of the coal dispute. An order has been placed with William Hamilton and Co., Ltd., Port-Glasgow, for a motor tanker to carry molasses in bulk for the United Molasses Company, Ltd., of London. The machinery for this vessel will be constructed by J. G. Kincaid and Co., Ltd., of Greenock. On the North-East Coast the Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, will build a similar ship for the same owners. Other new Clyde orders include three steamers of 5800 tons carrying capacity, which have been placed by H. Hogarth and Sons, of Glasgow, with Lithgows, Ltd., Napier and Miller, Ltd., and the Ayrshire Dockyard Company, Ltd. The propelling machinery for these ships is to be built by J. G. Kincaid and Co., Ltd., of Greenock, and David Rowan and Co., Ltd., of Glasgow. Messrs. Kincaid are also to supply the engines for an oil tanker which is being built to the order of Gow Harrison and Co., of Glasgow, by the Greenock Dockyard Company, Ltd.

The Coal Dispute.

THE miners' delegate conference having given the executive authority to continue negotiations with the Government unfettered by any restriction on the discussion of the hours' question, the executive and the Government resumed their meetings on Thursday and Friday of last week. On Saturday the executive reported the progress made to the delegate conference, which by a majority of 432,000 to 352,000 decided to recommend all districts to accept the terms of settlement proposed by the Government. The final result of the voting in the districts will not be fully known until after we have gone to press, but at the moment of writing the indications of a general acceptance are not clear. The Government terms as laid before the miners involve an undertaking on the part of the Miners' Federation to do all in its power to promote an immediate resumption of work on the basis of district settlements, the hours to be worked not being excluded from the district negotiations. When the Government is satisfied that these terms have been complied with it will introduce legislation providing for the reference of any district agreement to a national arbitral authority, the findings of which will have the force of law, which will have power to vary or confirm any district agreement subject to certain restrictions in detail. The arbitral authority would have powers conferred on it for six months only and would consist of members of the Industrial Court appointed by the Minister of Labour, together with two assessors, one appointed by each party to the appeal. Some difficulty arose over the question of reinstatement. The owners, it seems, have taken the stand that the miners will be reinstated as opportunity offers without prejudice to the men already at work, and the Government has not thought fit to interfere with this proposal. The miners' leaders, however, desired to see all the men taken on reinstated in their old places. They failed to carry their argument and eventually no clause governing the point was embodied in the memorandum of terms. The attitude of the owners to the proposed terms is at present not quite clear. The terms were formulated by the Government without agreement regarding them having previously been reached with either the Mining Association or the district colliery owners.

Watson House.

ON Wednesday of this week, the Chairman of the London County Council opened, at Battersea, a scientific and technical training centre, known as Watson House, for the Gas Light and Coke Company. At this establishment boys entering the gas industry from elementary and secondary schools will have the chance of eventually reaching high and responsible positions, without any initial advantages other than personal ability. The scheme is the result of a quarter of a century's endeavour on the part of Mr. David Milne Watson, governor of the Gas Light and Coke Company. Mr. Milne Watson has been President of the National Gas Council since its foundation, and occupies an eminent position in the gas industry. He was born at Edinburgh in 1869, and was called to the Bar in 1896. A year later he was appointed assistant general manager to the Gas Light and Coke Company, becoming general manager in September, 1903, managing director in May, 1916, and governor in 1918. The company's boy apprentices have hitherto been housed in somewhat cramped quarters at Westminster. It is hoped by the transfer to new and enlarged premises to give the boys an even better practical and scientific training than they have yet received. Arrangements will also be made for the training and testing of fitters and assistant fitters for work on consumers' premises.

Some Large Contracts.

ON Tuesday of this week it was officially announced that the Admiralty had awarded the contract for the construction of the floating dock for the Singapore naval base to Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne. The dock will be capable of lifting 50,000 tons and will measure 850ft. long by 170ft. wide. During the week it was also intimated that Howard and Bullough, Ltd., of Accrington, had received an order—of the value, it is stated, of £1,000,000—from the Australian Development Company for the equipment of a large cotton mill now under construction in Melbourne. Particulars have also just been published of a scheme which may eventually bring large contracts to this country. The scheme referred to is one for the construction of underground railways in Buenos Aires, and will, it is believed, involve an expenditure of some 20 million pounds. The railways will be modelled on the London system and will be carried out, it is understood, entirely by British interests.

Entropy and Probability.

By HERBERT BARNES, B.Sc.

No. II.*

THE exceptional character of the Second Law of Thermodynamics is shown in many ways, and not least by the difficulty which physicists have evidently felt in formulating it. Since thermal processes have been reduced to purely mechanical phenomena, the energy of heat being recognised to be the kinetic energy of the molecules, heat being, in fact, molecular motion, it might be thought that the known principles of mechanics should be applicable for the solution of the problems of heat. Such, however, is not the case, as we are well aware, and the reason is not far to seek. In the science of mechanics we deal with ordered motion; the co-ordinates and the motions of a point depend in some way on the co-ordinates and motions of other points. In the problems of heat we have to deal with entirely unco-ordinated movements. In place of the orderly procession of the planets in their orbits, for instance, where all is reducible to law, we have in the case of heat the picture perhaps of snow-flakes in a blizzard where all is confusion and chaos.

In the absence of any ordering principle, it is clear, since order would come only by chance, that such disorder must be the most probable state. In this we may see a reason why all other forms of energy (work, electrical energy, &c.) tend to be converted into heat. Order naturally gives place to chaos, but without some controlling principle there is no tendency for chaos to be reduced to order. The passage from one kind of order to another kind of order is in general a reversible process, the passage from order to chaos is in general irreversible; its reversal can only be exceptionally effected.

To solve these problems of elementary disorder the classical mechanics do not avail us. We need a new science of mechanics, the statistical mechanics of J. W. Gibbs. The statistical method has long been applied to the problems of social science, and to many problems of biological science. Maxwell in developing the kinetic theory of gases made one of the earliest applications of the statistical method to purely physical problems. In these physical applications one of the fundamental conceptions from which we start our investigations is that of the "*probability of a particular state.*" It is, then, axiomatic from the very meaning of the word "probability" that, in the absence of any ordering principle, the tendency will be for all systems, when they change in any way, to pass from less probable to more probable states; that is to say, the direction of evolution will be determined by the growth of probability.

It has already been stated that the direction of evolution is determined by the growth of "entropy." This statement is no more than an expression of the Second Law of Thermodynamics. As a purely mathematical abstraction, the conception of entropy has rendered possible the concise formulation of this law which otherwise has evidently not seemed possible. But now in the two statements just made we see established a certain relation between probability and entropy. As a matter of fact, a fairly simple functional relation between the "probability" of a particular state which we may denote by P, and the "entropy" φ exists. Following Boltzmann, we may see what this relation is without necessarily going very deeply into the theory of probability even. For putting

$$\varphi = f(\mathrm{P}) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where φ is the entropy of a particular state of the whole system considered, and P is the probability of that state, and calling φ_1, φ_2, φ_3—the several entropies of separate small parts of that system, and P_1, P_2, P_3—the probabilities of the several simultaneous states of the same separate small parts of the system, from the definition and the nature of entropy we know that

$$\varphi = \varphi_1 + \varphi_2 + \varphi_3 + \ . \ . \ . \ . \quad (2)$$

and from the elementary theory of probabilities

$$\mathrm{P} = \mathrm{P}_1 \times \mathrm{P}_2 \times \mathrm{P}_3 \times \ . \ . \ . \ . \quad (3)$$

that is to say, the probability P of the simultaneous occurrence of several independent states is equal to the product of the several probabilities P_1, P_2, P_3, &c., of the individual states, and also noting that

$$\varphi_1 = f(\mathrm{P}_1),\ \varphi_2 = f(\mathrm{P}_2),\ \&c. \quad . \ . \ . \quad (4)$$

we have, for φ the total entropy—

$$\begin{aligned}\varphi &= \varphi_1 + \varphi_2 + \varphi_3 + \ . \ . \ . \\ &= f(\mathrm{P}_1) + f(\mathrm{P}_2) + f(\mathrm{P}_3) + \quad . \ . \ . \ . \ . \quad (5)\end{aligned}$$

and from this, in conjunction with equations (1) and (3), we see that

$$f(\mathrm{P}_1) + f(\mathrm{P}_2) + f(\mathrm{P}_3) + \ . \ . = f(\mathrm{P}_1\,\mathrm{P}_2\,\mathrm{P}_3 \ . \ ) \quad (6)$$

The function which satisfies equation (6) is, of course, $\log_e$, and we have

$$\varphi = k \,.\, \log_e \mathrm{P} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (7)$$

The proportionality factor k is a universal constant, the value of which is

$$k = \frac{\mathrm{R}}{\mathrm{N}}$$

where R is the gas constant, equal to $8{\cdot}315 \times 10^7$ ergs/degree/gram-molecule, and N is the Avogadro-Loschmidt number, the number of molecules in one gram-molecule of a gas $= 6{\cdot}074 \times 10^{23}$, whence

$$k = 1{\cdot}369 \times 10^{-16} \text{ ergs/degree},$$

the *absolute* gas constant referred not to one gram-molecule but to *one molecule*.

Equation (7) is the most general definition of entropy. P is here the thermodynamical probability of a particular state, and will always be represented by a whole number. It will be the numerator of a proper fraction which will represent the mathematical probability p of that particular state.

To approach the problem of the calculation of probability in an elementary manner, let us consider the following simple case. Let us suppose that we have a vessel divided into two equal compartments, separated by a removable partition—see Fig. 2. In one compartment we have a gas at pressure p, consisting of n molecules. The other compartment we suppose initially perfectly void. The problem is, how will the molecules be distributed between the two compartments if the partition be removed? According to classical theory, we say that the gas immediately expands so as to occupy the whole vessel, the pressure throughout will be reduced to half, *i.e.*, $p/2$, and the number of molecules in each separate compartment will be at any instant after equilibrium has been restored $n/2$.

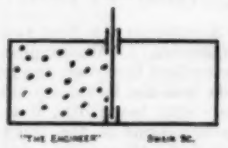

FIG. 2

How do we proceed to solve this problem by the statistical method? Postulating the absence of any ordering principle, we say that *a priori* all distributions of the molecules are equally possible at any instant. Considering always an instantaneous state, let us suppose that there are m molecules in the left-hand compartment; there will then be $n - m$ molecules in the right-hand compartment. This numerical distribution may, however, arise in several different ways. For example, let us suppose a simple case of 5 molecules a, b, c, d, e, and let the distribution be 3 molecules in the left-hand compartment and 2 molecules in the right. We have then

$$\begin{aligned} n &= 5 \\ m &= 3 \\ n - m &= 2, \end{aligned}$$

and we see in Table I. the ways in which this distribution may be brought about. The number of ways is

$$\mathrm{P} = \frac{5\,!}{3\,!\ 2\,!} = 10.$$

TABLE I.

Left.	Right.
$a\,b\,c$	$d\,e$
$a\,b\,d$	$c\,e$
$a\,b\,e$	$c\,d$
$a\,c\,d$	$b\,c$
$a\,c\,e$	$b\,d$
$a\,d\,e$	$b\,c$
$b\,c\,d$	$a\,e$
$b\,c\,e$	$a\,d$
$b\,d\,e$	$a\,c$
$c\,d\,e$	$a\,b$

TABLE II.

Left, m.	Right, $n - m$.	P	$p = \frac{\mathrm{P}}{\Sigma\,\mathrm{P}}$
5	0	1	1/32
4	1	5	5/32
3	2	10	10/32
2	3	10	10/32
1	4	5	5/32
0	5	1	1/32
		$\Sigma\,\mathrm{P} = 32 = 2^5$	

Generally the number of ways in which a particular numerical distribution—that is to say, a particular state in our case—may arise is

$$\mathrm{P} = \frac{n\,!}{m\,!\ (n - m)\,!} \quad . \ . \ . \ . \quad (8)$$

which is the number of combinations of n things taken m at a time, or, what amounts to the same thing, $(n - m)$ at a time. This number, then, represents the probability of that particular state. To obtain the mathematical probability which, as we know, is always a proper fraction, we must divide this number by the sum of all the possible combinations of n things taken 1, 2, 3, . . . n at a time respectively. This, as we know, is given by 2^n, and we have for the mathematical probability of the particular state

$$p = \frac{\mathrm{P}}{\Sigma\,\mathrm{P}} = \frac{1}{2^n} \quad \frac{n\,!}{m\,!\ (n - m)\,!} \quad . \quad . \quad (9)$$

The probability reaches a maximum when $m = n/2$, that is to say, the most probable state is that of an equal distribution of the molecules between the two compartments. The probability of a complete return to the initial conditions, $m = n$, is

$$p = \frac{1}{2^n} \times \frac{n\,!}{n\,!\ 0\,!} = \frac{1}{2^n}$$

If the volume of each compartment is 1 cubic centimetre, then at 0 deg. Cent. and 760 mm. pressure, the number of molecules is

$$n = 2{\cdot}705 \times 10^{19},$$

and the probability of a complete return to the initial state so small, that even in billions of years this state would hardly arise. The important thing, however, is that the probability of such a state is never nil; the phenomenon which we have considered is, strictly speaking, reversible. The same is true in the case of the transfer of heat. Considering still our case of the expansion of a gas, according to Verschaffelt, the following formula gives the number of molecules per cm.^{3}

$$n = 7{\cdot}40 \times 10^{21} \times \frac{p_{at.}}{\mathrm{T}}$$

where p_{at} is the pressure in atmospheres and T the absolute temperature. At T = 2 deg. absolute the vapour pressure of hydrogen is 10^{-20} atmospheres, and $n = 37$ molecules/cm.^{3}. At one-tenth of this pressure $n = 4$, and the probability of a return to the initial state in such a case would not be so exceedingly small. At very small temperatures and pressures we might expect to find that the Second Law of Thermodynamics would lose a great deal of its positive character, and such, in fact, we do find to be the case. These examples may enable us to appreciate more fully the significance of the statements which have been made concerning this law, namely, that it has its origin in no causal principle, but rather in a principle of probability.

Returning to the case which we have been considering, that of the expansion of a gas, of all states the most probable is the even distribution of the molecules between the two compartments, *i.e.*, $m = n/2$, but the greater n is the less is the probability of an *exactly* even distribution. In Table III. the probabilities of the various states are shown for the case of 10 molecules:—

TABLE III.

$m =$	10	9	8	7	6	5	4	3	2	1	0
$n - m =$	0	1	2	3	4	5	6	7	8	9	10
P =	1	10	45	120	210	252	210	120	45	10	1

$\Sigma\,\mathrm{P} = 2^{10} = 1024$, and the mathematical probability $\mathrm{P}/\Sigma\,\mathrm{P}$ for the distribution 5/5 is

$$p_\circ = \frac{252}{1024} = 0{\cdot}245.$$

Distributions from 6/4 to 4/6, that is, varying not more than 20 per cent. from the mean, will be very frequent, the probability being

$$p = \frac{210 + 252 + 210}{1024} = 0{\cdot}656$$

The probability of greater variations than 20 per cent. from the mean is thus only 0·344, and similarly the probability of variations greater than 40 per cent. from the mean may be seen to be 0·11 only.

In general, the mathematical probability of a perfectly even distribution $n/2$ against $n/2$ is

$$p_\circ = \frac{1}{2^n} \quad \frac{n\,!}{\frac{n}{2}\,!\ \frac{n}{2}\,!}$$

Stirling's approximate formula gives

$$n\,! = \left(\frac{n}{e}\right)^n \sqrt{2\,\pi\,n} \quad . \ . \ . \ . \quad (10)$$

whence we derive the approximate formula

$$p_\circ = \sqrt{\frac{2}{\pi\,n}} \quad . \ . \ . \ . \ . \quad (11)$$

We now want to find out what is the probability of a distribution differing by an assigned amount from the mean, that is, in our example, $n/2 - \nu$ molecules on the left and $n/2 + \nu$ on the right. Equation (9) gives us

$$p_\nu = \frac{1}{2^n} \cdot \frac{n\,!}{\left(\frac{n}{2} - \nu\right)\,!\ \left(\frac{n}{2} + \nu\right)\,!} \quad . \quad (12)$$

Using Stirling's formula, and remembering that n is very large, we get

$$p_\nu = \sqrt{\frac{2}{\pi\,n}} \quad \frac{1}{\left(1 - \frac{2\nu}{n}\right)^{\frac{n+1}{2} - \nu} \left(1 + \frac{2\nu}{n}\right)^{\frac{n+1}{2} + \nu}} \quad (13)$$

Taking logarithms and making use of the expansion

$$\log_e\left(1 \pm \frac{2\,\nu}{n}\right) = \pm\,\frac{2\,\nu}{n} - \frac{1}{2}\,\frac{4\,\nu^2}{n^2} \pm \ . \ .$$

in which we may neglect higher powers of $\frac{\nu}{n}$, since ν is supposed small in comparison with n, we have

$$\log_e p_\nu = \log_e \sqrt{\frac{2}{\pi\,n}} - \frac{2\,\nu^2\,(n-1)}{n^2} \quad . \quad (14)$$

$\frac{n-1}{n^2} = \frac{1}{n}$, since n is large, and so, combining equation (14) with equation (11), we obtain

$$p_\nu = p_\circ\, e^{-\frac{2\,\nu^2}{n}} \quad . \ . \ . \ . \ . \quad (15)$$

This function is shown graphically in Fig. 3. For small values of ν, $p_\nu \sim p_\circ$, that is, all distributions varying but slightly from the mean, are almost equally probable. The curve becomes steeper and more and more pointed as the absolute numerical value of n increases; the greater n is, the more unlikely is any given percentage deviation from the mean state. The function is the same as the Gaussian

* No. I. appeared November 12th.

function for the probable error, and the analogy is not merely mathematical; it is also physical.

We want now to find the probability that the distribution may be within certain assigned limits of variation from the mean. We want the sum of

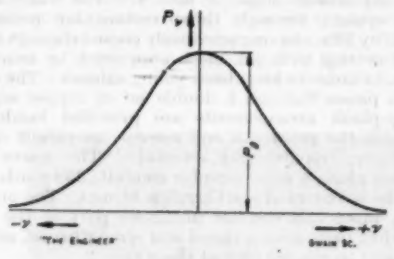

FIG. 3

the probabilities of all states in which ν does not exceed an assigned value ν_0.

$$\left|p\right|_{-\nu_0}^{+\nu_0} = p_0 + 2\sum_{\nu=1}^{\nu=\nu_0} p_\nu = p_0\left(1 + 2\sum_{\nu=1}^{\nu=\nu_0} e^{-\frac{2\nu^2}{n}}\right)$$

If ν_0 and ν_0^2 are both small in comparison with $n/2$, then

$$e^{-\frac{2\nu^2}{n}} \sim 1 - \frac{2}{n}\nu^2$$

and

$$\sum_{\nu=1}^{\nu=\nu_0} e^{-\frac{2\nu^2}{n}} = \nu_0 - \frac{2}{n}\sum_{\nu=1}^{\nu=\nu_0}\nu^2 = \nu_0 - \frac{2}{n}\frac{\nu_0(\nu_0+1)(2\nu_0+1)}{1.2.3.}$$

and so, considering $\frac{\nu_0}{n}$ and $\frac{1}{3n}$ negligible compared with unity,

$$\sum_{\nu=1}^{\nu=\nu_0} e^{-\frac{2\nu^2}{n}} = \nu_0 - \frac{2}{3}\frac{\nu_0^3}{n}$$

and therefore

$$\left|p\right|_{-\nu_0}^{+\nu_0} = p_0\left[1 + 2\nu_0\left(1 - \frac{2}{3}\frac{\nu_0^2}{n}\right)\right] \quad . \quad . \quad (16)$$

The probability that this assigned variation may be exceeded will then be, of course,

$$1 - \left|p\right|_{-\nu_0}^{+\nu_0}$$

Let us now make use of these equations. We shall find the result interesting if we calculate, for example, for different values of n the probability of a variation from the mean distribution such that the number of molecules in either compartment shall differ by more than one-millionth from the mean number. Then

$$\frac{\nu_0}{\frac{n}{2}} = \frac{1}{10^6}$$

Owing to the assumptions we have made, the validity of equation (16) will be restricted within certain limits, which will be roughly

$$10^6 < \frac{n}{2} < 10^{12}.$$

Using equations (11) and (16) we obtain the results shown in Table IV.

TABLE IV.

$\frac{n}{2}$ =	10^8	10^7	10^8	10^9
ν_0 =	1	10	10^2	10^3
p_0 =	$0{\cdot}0_5564$	$0{\cdot}0_5178$	$0{\cdot}0_4564$	$0{\cdot}0_4178$
$\left\|p_0\right\|_{-\nu_0}^{+\nu_0}$ =	·0017	·0037	·0113	·0356
$1-\left\|p_0\right\|_{-\nu_0}^{+\nu_0}$ =	·9983	·9963	·9887	·9644

TABLE IV. (*continued*).

$\frac{n}{2}$ =	10^{10}	10^{11}	2×10^{11}	5×10^{11}
ν_0 =	10^4	10^5	2×10^5	5×10^5
p_0 =	$0{\cdot}0_5564$	$0{\cdot}0_5178$	$0{\cdot}0_5126$	$0{\cdot}0_580$
$\left\|p_0\right\|_{-\nu_0}^{+\nu_0}$ =	·113	·344	·471	·667
$1-\left\|p_0\right\|_{-\nu_0}^{+\nu_0}$ =	·887	·656	·529	·333

For numbers up to a few thousand millions of molecules we see that variations of more than a millionth from the mean distribution are the rule. When $n = 10^{12}$ the probability of such a variation is only 1/3 by our calculation, and is in actual fact less than that, because we have reached a point where our formula ceases to be accurate. This example shows very forcibly the steadying effect of numbers on statistics. The function (equation 16) is shown plotted in Fig. 4. The probability of exceeding the given variation tends asymptotically towards zero as the number of molecules is increased, but the approximate formula which we have used is no longer serviceable and for greater values of n we should have to contrive other formulæ for the calculation.

In the foregoing example we have seen the theory of probabilities applied to the expansion or effusion of a gas. The problem of the flow of heat is somewhat more complicated, but otherwise it is strictly analogous. In the case of the expansion of a gas it is the distribution in space of the molecules which we determine, and we find that the probability is in favour of the passage always from a less even distribution to a more even distribution of the molecules among the parts of space. In the case of the flow of heat we are concerned, not with the movement of matter among the parts of space, but with the movement or transference of energy among the parts of matter. Probability works the same way here; it favours always the passage from a less even to a more even distribution of kinetic energy among the molecules; in other words, it tends towards an equipartition of molecular energy; that is to say, towards the equalisation of temperature in all the parts of any given system. The passage of heat in the reverse direction—that is, from the colder to the warmer parts of any system—would mean simply the exaggeration of already existing inequalities in the distribution of kinetic energy among the molecules, and this is against probability just as the heaping up of the molecules of a gas in any particular portion of the space which the gas occupies is against probability, as we have already seen. The vastness of the improbability that either of these actions should take place naturally to any marked extent, we are now well able to

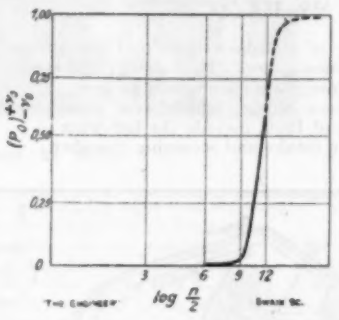

FIG. 4

appreciate from a consideration of the results of the calculations of probability which we have just made. We may now understand the real character of the Second Law of Thermodynamics, the law of entropy; this law is not necessarily the result of the action of any causal principle, it follows inevitably from the free operation of the laws of probability alone. It is probability alone which determines the *direction* of the irreversible processes of nature; the *rate* at which these processes take place depends on other circumstances, it depends on all the contraints to which the parts of a system are subjected, on the propinquity or otherwise of the parts, and so forth.

Maxwell and Clausius first applied the theory of probabilities to the determination of the speeds of the molecules when they were working out the kinetic theory of gases. In more recent times J. W. Gibbs has demonstrated how the laws of probability are operative in nearly every kind of natural phenomenon, more especially in the phenomena of chemical change, and he is, to a great extent, the founder of the new science of statistical mechanics. M. von Smoluchowski, pre-eminently, has investigated the phenomena of diffusion and of the Brownian movements. The following figures of v. Smoluchowski are interesting. The problem of the local fluctuations in the concentration of a particular gas in a mixture of gases is exactly analogous to the problem which we have already dealt with numerically, that of the local fluctuations of density in a homogeneous gas. The figures below refer to the oxygen concentration in air; the space considered being the volume of a sphere of radius a, the probability of a variation of more than 1 per cent. in the oxygen concentration is expressed by v. Smoluchowski as follows, in terms of time, θ being the average interval between successive occurrences of the phenomenon in question.

a =	1×10^{-6}	$2{\cdot}5\times10^{-5}$	3×10^{-5}	5×10^{-5}	1 cm.
θ =	10^{-11}	1	10^8	10^{28}	$10^{(10^{14})}$ sec.

We see again that where the space considered is very small such variations are the rule and very much greater variations must therefore be of common occurrence. The remarkable thing, however, about these figures is the enormous diminution in the probability for only a slight increase in the volume of the space considered.

It would seem that science is just beginning to appreciate the importance of the part played by probability in purely physical processes. In the seventeenth Kelvin Lecture which Sir J. J. Thomson delivered before the Institution of Electrical Engineers some few months back he dealt with the latest developments of electrical science and discussed the question whether the equations of classical electrodynamics are really as fundamental as they have been thought to be or whether they also, like the equations of thermodynamics, do no more than express statistical truths. The phenomenal laws of electricity have seemed to be peculiarly amenable to exact mathematical expression, as if they at all events had their origin in some definite causal principles of nature. The most recent investigations, however, lead us to suppose that even such a law as Coulomb's law of attraction and repulsion of opposite and like electric charges respectively according to the inverse square function may be merely a statistical law; what is apparently a steady force may be the mean effect of a great number of separate small impulses occurring at all sorts of irregular intervals not individually, but only statistically, determinable. In fact, the classical dynamics themselves, the mechanics of the "Principia," might seem in some way to be threatened, and even the laws of motion lose something of their absolute character, though it also seems true that Newton's genius shines with a particular brightness at the present time, and his own words reveal a deeper insight into the processes of nature than has been displayed by many of his brilliant commentators of succeeding ages. For the modified interpretations which we may have to assign to the Second and Third Laws of Motion in the light of modern discovery are probably nearer to Newton's own conceptions than have been the mathematical and physical interpretations commonly placed on these laws at any time during the two intervening centuries between his day and our own. On other subjects of natural philosophy also, besides mechanics, we may still study Newton with profit.

The part played by probability in the operations of inanimate nature opens up questions of profound philosophical interest. As the mechanical laws lose something of their absolute character and give place in increasing measure to the laws of probability, the worlds of inanimate nature, of life, and of intelligence seem all to be brought into closer contact. If Maxwell was right and if his "demons," endowed with intelligence no greater than our own, but with finer means at their disposal, would be capable in certain circumstances of reversing the natural order of events as regards the operation of the Second Law of Thermodynamics, then may it not also be true that it is not the intelligence, but only the means, which we lack to enable us to influence directly the operation of the forces of nature in other spheres of action? At any rate it becomes almost conceivable how intelligence might so operate.

However, such speculations are apart from the object of the present article, which is to present the "law of entropy," the Second Law of Thermodynamics, as a principle of probability, according to Boltzmann. The reader will find the subject treated more fully in the original article of Professor Plank, "Begriff der Entropie," in the issues of June 19th and July 3rd of the *Zeitschrift des Vereines Deutscher Ingenieure*, and he will there find many reflections of a philosophical nature in connection with it. For the substance of the present article the writer is indebted almost entirely to Professor Plank's excellent and fascinating production.

New Water Supply Works for Aberdeen.

ON September 30th last new water supply works for Aberdeen were formally put into service by H.R.H. Princess Arthur of Connaught.

The water supply of the city has been drawn from the river Dee for nearly a century. At first the water was pumped from an intake close to the city. Since 1866 the supply has been abstracted from the river at Cairnton, 20 miles west of the city. The works, completed in 1866 by the late Mr. James Simpson, Past-president of the Institution of Civil Engineers, supplied most of the city by gravitation, and there was for twenty years enough surplus capacity in the aqueduct to pump the water required in the higher areas by water power. The works were of a type usual for river supplies, viz., a 12 million gallon storage reservoir, filter beds (half an acre), an aqueduct capable of passing 8 million gallons per day, and service reservoirs of 6½ million gallons capacity. When designed, the works were well proportioned, but for half a century no increase was made in the storage or filter plant, although the population supplied had during that time increased considerably. This fact led to strong opposition being raised to the continuance of the river Dee as the source of supply. The controversy was a strenuous one, nearly every British water engineer of prominence being engaged in it. The struggle was on somewhat the same lines as in the case of London, and it ended in the same way—the source was retained.

From 1894 to 1914 the river water received no treatment beyond storage for 1½ days. It then passed along a leaky aqueduct for a distance of 18½ miles to service reservoirs near the city, having a capacity of four days' supply. This might seem to be a highly imprudent procedure, but it is a curious fact that the enteric case rate in Aberdeen during that period was very much lower than the case rates in the other large towns of Scotland, all of which had water supplies that were reckoned to be much better than that of Aberdeen. For thirty years the sewage from the villages on the drainage area has been treated on irrigation farms. A slight outbreak of enteric in 1912, now believed to be due to infected milk, caused more

attention to be given to the purification of the water.

In 1913, at the suggestion of Sir Alexander Houston, a successful trial was made at Invercannie of the excess lime sterilisation process. Therefore a liming plant was constructed.

From 1914 to 1916 the treatment of the water was

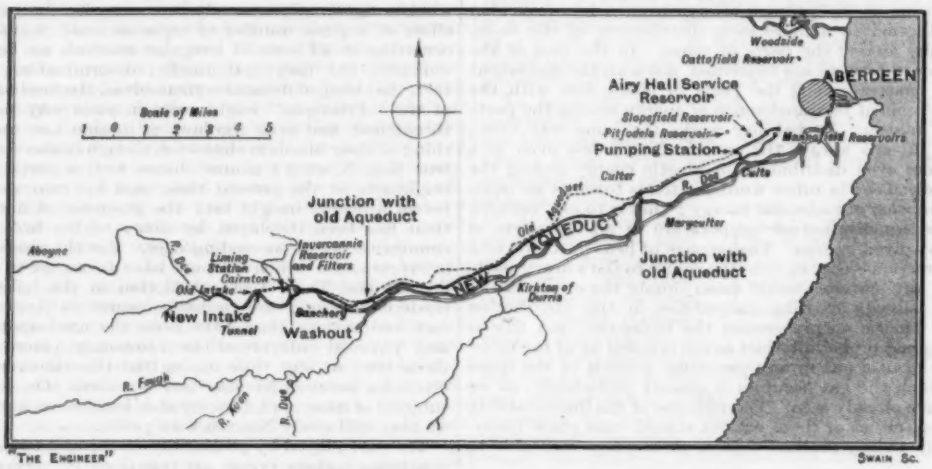

FIG. 1—PLAN SHOWING ROUTES OF OLD AND NEW AQUEDUCTS

as follows, viz.:—The water was sterilised by the addition of about 1¼ parts per 100,000 of actual CaO in the form of milk of lime. It then received 1¼ day's storage in a well-baffled reservoir. In 1916, 2 acres of slow sand filters were completed, and filtration was substituted for the lime sterilisation treatment.

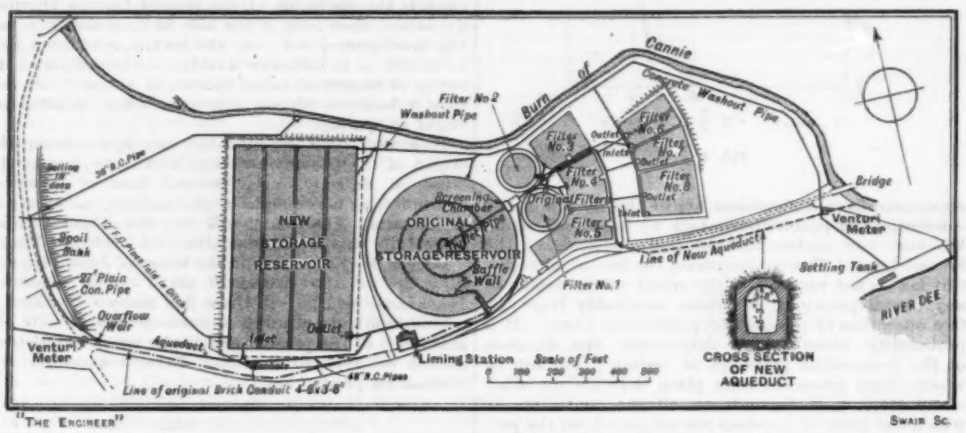

FIG. 2—PLAN OF THE WATERWORKS AT INVERCANNIE

In 1915 it was decided still to adhere to the river Dee as a source of supply, and in 1916 parliamentary powers were obtained to construct an entirely new waterworks. The engineer for the Bill was the then City Water Engineer, Mr. Cecil H. Roberts, M. Inst. C.E. The new, in conjunction with the old waterworks will provide a supply at the rate of 10 million gallons per day, or an increase of about 40 per cent. over the present volume, which is a little over 7 million gallons per day, to a population of 160,000 persons. The city is fortunate in that no compensation, either in money or water, is given in respect of the abstraction from the river, which has a minimum flow of about 110 million gallons per day. The storage now available at the intake is equal to five days' supply of the present average day's consumption. There are 3·4 acres of slow sand filters, and, near the city, service reservoirs are provided which have a capacity of five days' supply of the present average day's consumption. The liming plant is also retained as an emergency purification process.

The new works, which were commenced in the autumn of 1920, include the following :—

(1) An intake and screening chamber ;

(2) An intake conduit with a capacity of 20 million gallons per day ;

(3) A storage reservoir with a capacity of 24 million gallons ;

(4) Slow sand filters with areas of 0·4, 0·4 and 0·6 acres respectively ;

(5) An aqueduct, 17½ miles long, with an initial capacity of 11 million gallons per day and an ultimate capacity of 14 million gallons per day ;

(6) A pumping station with a total pumping capacity of 11·3 million gallons per day : and

(7) A 7 million gallon service reservoir.

FIG. 3—THE OLD AND NEW INTAKES

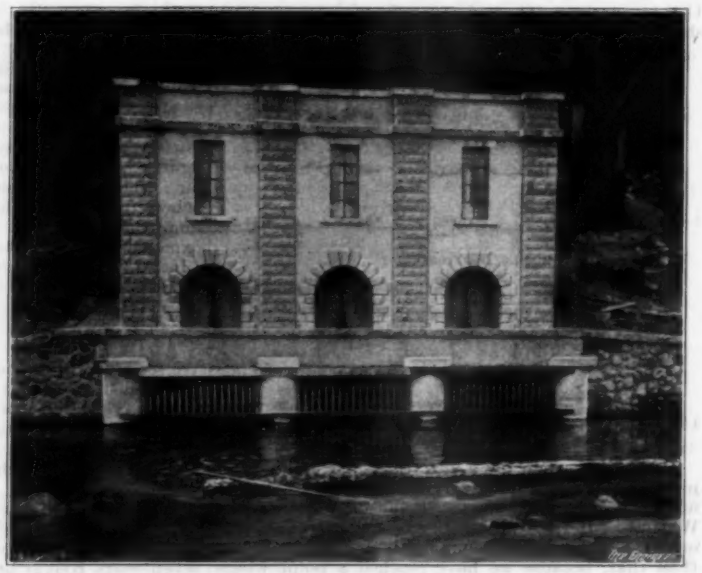

FIG. 4—FRONT VIEW OF NEW INTAKE

For the particulars given in what follows we are indebted to Mr. G. Mitchell, the City Water Engineer.

New Intake and Screening Chambers, Intake Conduit and Storage Reservoir.

The new intake is situated 200ft. upstream from the old intake—Figs. 3 and 4. The water enters the system through three rectangular penstocks, 48in. by 32in., having previously passed through heavy wire netting with ¾in. mesh supported by iron gratings, in order to keep back young salmon. The water then passes through a double set of copper screens. Stop-plank arrangements are provided inside and outside the penstocks and screens, to permit of any necessary repairs and renewals. The water then passes along a 60in. circular conduit, 350 yards long, to the west end of the Cairnton tunnel. The old cast iron pipes and conduit alongside part of the 60in. conduit have been scraped and strengthened, and are utilised to convey part of the water.

In order to prevent pollution of the water supply

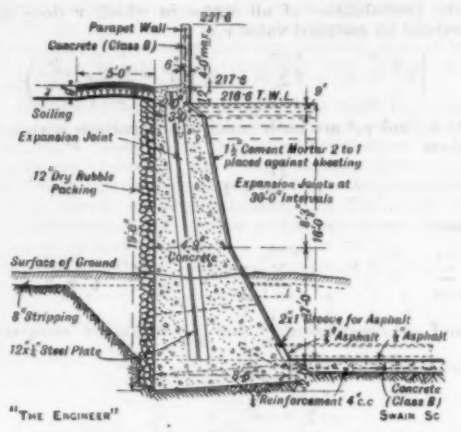

FIG. 5—SECTION OF STORAGE RESERVOIR WALL

during the construction of the new intake and intake conduit, it was necessary to pump the water through a 24in. steel pipe line into the west end of the Cairnton tunnel. Two 62–68 brake horse-power Crossley cold-starting crude oil engines, driving Beardmore centrifugal pumps, were employed for this purpose. Each pump had a capacity of 7 million gallons per day. As the level of the water in the tunnel was practically the same as at the point of intake, the engines had very little work to do when once the pipe line had been filled, as there was merely the friction in the pipe line to be overcome. The pumps thus worked with suction on both the intake and delivery sides. The plant worked very satisfactorily, there being no breakdown of any kind.

The Cairnton tunnel, which is approximately 5ft. by 4ft. in section, is in unlined rock. It will be widened at narrow parts, and the invert will be lowered and concreted as opportunity permits. East of the tunnel a new concrete conduit, 6ft. by 3ft. by 600 yards long, conveys the water to the new storage reservoir. On the conduit a 4ft. diameter depressed section has been formed for the insertion of a Venturi meter of the water column type. This meter is provided in accordance with the requirements of the 1916 order, so that any parties interested in the abstraction of water from the river may satisfy themselves at any time as to the rate of abstraction. The capacity of the conduit is 20 million gallons per day.

It was originally intended that the reservoir at

Invercannie should have rather more than double its actual capacity, which is 24 million gallons, but experience of the working of the provisional purification works from 1916 to 1920 led to the reduction of the capacity. The reservoir—Fig. 2 and Figs. 8 and 9, page 554—has concrete retaining walls and a concrete floor covered with a ½in. layer of asphalt. The walls of the reservoir—Fig. 5—were constructed in 30ft. lengths, each completed in one day. The concrete is a 1 : 2½ : 4½ mixture, and a 1½in. thick facing of 2 to 1 sand cement mortar was worked on to

FIG. 6—INTERIOR OF PUMPING STATION AT CULTS

the concrete as the wall rose. The lengths are interlocked, expansion plates, 12in. by ½in., were built in, and the ends were painted with a thick coating of pitch. The floor was constructed of 1 : 2½ : 4½ concrete deposited in regular alternate bays. Certain of the bays were left open till the reservoir was almost completed, but apart from that, no special provision for expansion was made in the floor. As the floor level is considerably below the level of the stream alongside, the whole area was underdrained, to prevent danger from uplift.

In order to prevent short circuiting of the water from inlet to outlet, the reservoir is divided into four bays by means of reinforced concrete baffle walls of ⊥ section with buttresses at 20ft. intervals. The water is drawn from the reservoir by means of three outlet penstocks, 36in. in diameter, situated one near the bottom, one near the surface, and the third midway between, that arrangement having been made to assist in promoting vertical circulation of the water.

Additional Filter Beds.

The three additional filter beds, which, as has been said, have sand areas of 0·4, 0·4 and 0·6 acre respectively—see Fig. 10, page 554—are of the usual type of slow sand filters, containing 3ft. of fine sand over 10in. of graded gravel. They have been designed so that the surface may be cleaned by flushing with water and "squeegeeing" the mud off into a central waste water channel, the surface being thereafter harrowed and rolled. Concrete wash water channels are therefore provided on the long sides of the beds, and the surface of the sand is slightly inclined from the sides towards the centre. This system was devised by Mr. T. Caink, A.M. Inst. C.E., and has been in successful operation at Worcester for a dozen years. As the surface is not completely cleaned, a thickened film is produced, which gradually attains a depth of a few inches. When that stage is reached the sand is taken out, washed and replaced. It is believed that this procedure will be specially suitable for a clear water like the Dee—which does not produce much film on an ordinary filter—because the filters will ripen more rapidly and work more efficiently. This system also keeps the sand always at the maximum depth, enables a bed to be cleaned very quickly—which is important in cold situations in the winter—and permits of economies in construction and maintenance.

From experience of filtration at Aberdeen and elsewhere, it would appear that many waters can be efficiently filtered at rates much exceeding the standard rate, and that the present area of filters at Invercannie will suffice for a long time to come.

New Aqueduct.

The new aqueduct from the Invercannie filters to Mannofield No. 2 service reservoir is 17·4 miles in length—see Fig. 1—and consists of (1) 0·7 mile of concrete cut and cover, 5ft. 3in. by 3ft. 8in.; (2) 2 miles of 46·2in. cement-lined steel pipes; (3) 9·6 miles of 38in. cement-lined steel pipes; (4) 3 miles of 46·5in. cement-lined cast iron pipes; (5) 0·5 mile of 46·2in. cement-lined steel pipes—at this point, Cults, a 29in. cement-lined cast iron pipe branches off to the Cults pumping station—(6) 1 mile of 44·2in. cement-lined steel pipes; and (7) 0·6 mile of 48in. concrete conduit. All the diameters given refer to the pipe as finished. It will be seen that the western 2·7 miles and the eastern 5·1 miles are of larger size than the central 9·6 miles. At a later date this central length of the old aqueduct will be repaired and utilised to convey about 6 million gallons per diem, junctions being made with the new aqueduct at Banchory and Culter. The designed ultimate aqueduct capacity is 14 million gallons per diem, but the capacity will be at the rate of about 11 million gallons in the first instance. For the first instalment, therefore, the hydraulic gradient will be flat at the east and west ends, and steeper in the central section.

The water entering the aqueduct is measured by a 4ft. Venturi meter of the water column type.

The question of the employment of reinforced concrete piping for the aqueduct was thoroughly investigated. The soil in this locality is suitable for either concrete or steel pipes, as there are no constituents likely to cause corrosion. The quotations received for reinforced concrete piping were, however, not favourable.

Steel pipes mainly were used for large diameters. They were made in lengths of 18ft. to 25ft., and had

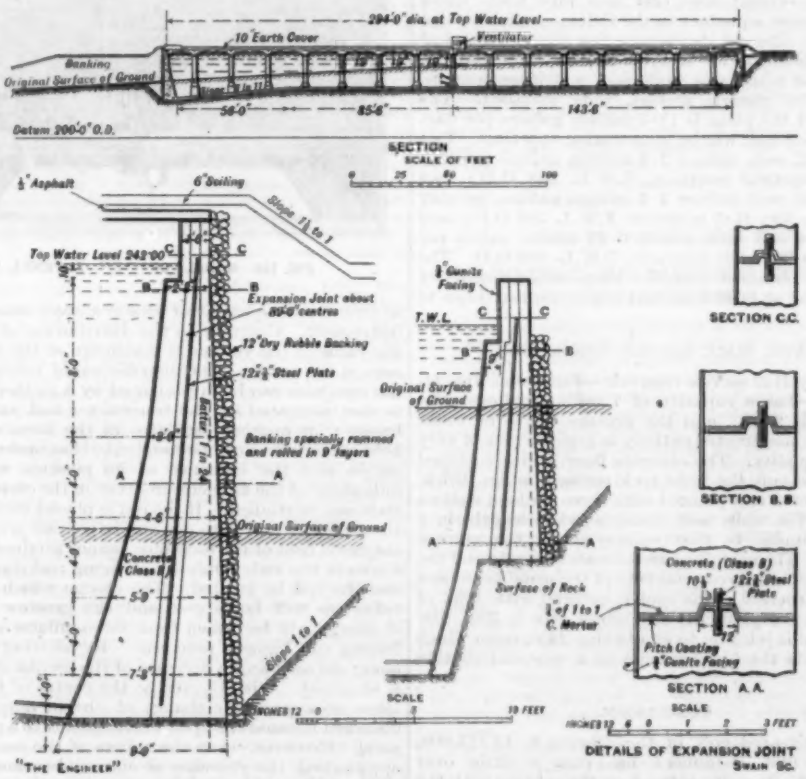

FIG. 7—SECTIONS OF AIRY HALL SERVICE RESERVOIR AND ITS WALLS

two longitudinal lap welds in each pipe, that construction being cheaper and giving less chance of corrosion than if short lengths with one weld, riveted together, had been used. The steel was specified to have a tensile strength of 24 to 28 tons per square inch, an elongation of 20 per cent. on a gauge length of 8in., and a contraction of area of 45 per cent. The tests of the steel employed showed an average elongation of 28 per cent., and an average contraction of area exceeding 50 per cent. with the standard test piece. Regular cold-bending tests round a 3in. shaft were made of the actual welds, and the average strength of the welds was found to exceed 90 per cent. of that of the solid plate, while the average elongation was about 15 per cent. with the standard test piece.

The metal pipes were all lined with concrete except a length of 400ft., which was lined with bitumen. About 3½ miles of the work was lined by hand, the rest being lined by the spinning process. Most of the steel pipes were coated on the outside with asphalt and wrapped with hessian cloth. A length of 2 miles of 48in. steel pipes was treated on the outside with bitumastic solution and bitumastic enamel. The first 48in. steel pipes laid were ⅞in. thick, and the sockets were formed with a sharp bell-mouth to strengthen the socket to resist caulking stresses. For thicker 48in. pipes the bell-mouth was omitted, as it was also in the case of 40in. by ⅞in. pipes. For 40in. pipes of ⅞in. or over in thickess, there does not seem to be any need for the strengthening ring which is sometimes shrunk on to the socket. There was no case of a socket being damaged by caulking. The 46in. and 44in. pipes were bedded in mortar on small blocks of concrete set about 5ft. apart. Thereafter a small saddle of fine concrete was placed so as to embrace about 20 per cent. of the periphery of the pipe. The pipe sockets were 4½in. deep, and were partly filled with moist 1 to 1 sand cement mortar, hammered solid with heavy blows. After that had set for at least two hours, the socket was hammered full of lead wire by hand or pneumatic caulking.

The 3 miles of 46½in. cast iron pipes were lined centrifugally with 1in. of 2 to 1 sand cement mortar. At first there was a little difficulty in adjusting the water content of the mortar, but by cutting it down to a minimum, and using an efficient type of machine mixer, a very good finish was obtained. The maximum working pressure in the pipe line is about 100 lb. per square inch. The pipes on the lower part of the length and all pipes under public roads are 1½in. in thickness. Where the pressure is very low the pipes are 1¼in. in thickness. Test bars showed an average tensile strength of 10·2 tons per square inch, and the average deflection was 0·38in. on a standard bar. The pipes were coated externally with two coats of Angus Smith's solution, with an interval of 10 minutes between the applications. After the pipes were laid and jointed, they were tested in lengths averaging about one-fifth of a mile, by means of compressed air to a pressure of 100 lb. per square inch. It is essential in the case of large cast iron pipes that, not only the joints, but also the pipes themselves should be tested before being covered up, and as compressed air was used for various plant on the works, it was adopted as a testing medium. The supporting of the heavy end pressure during a test required careful work. The face of earth at the end of a trench was trimmed as true as possible, and against it was placed a double thickness of 9in. by 9in. dressed pitch pine timbers, forming a block 8ft. square. A similar block of timbers provided with a thick sheet of rubber was placed against the socket end of the last pipe laid. The blocks of timber were strutted apart by hydraulic jacks bearing on steel joists. The joints between the pipes were similar to those in the other sections, except that the sockets were 3½in. deep and lead wire was used to a depth of 2½in. The compressed air test is severe and tended to raise the standard of the workmanship of the caulking. It is believed that this is the first pipe line of its size and length in this country that has been tested under pressure before the trench was refilled. Such testing is very well worth

while, and, in the opinion of Mr. Mitchell, the city water engineer, should be standard practice. The majority of the joints were caulked by pneumatic tools. Drag line excavators were used to some extent for the looser materials and small steam shovels in harder stuff. In timbered trenches the excavations were usually handled by locomotive cranes.

There were a few short tunnels on the pipe line. In them, steel pipes of a minimum thickness of ¼in. were laid, and the whole space around the pipes was packed solid with concrete of a minimum thickness of 18in. In deep cuttings steel pipes were stiffened by narrow ribs of concrete at intervals, and cast iron pipes were partly surrounded with concrete. Steel pipes were employed at three points where the pipe line crossed under the Deeside railway, and, after testing, were encased in a block of concrete, 7ft. square in cross section.

The stop valves are of standard diameters, and are practically the full diameter of the pipes, since the fall available is only about 2ft. per mile. The majority are provided with live rollers and ball bearings. In the country the stop valves are spaced about 1 mile apart, but near the city they are spaced at ½ mile intervals. At two points automatic shut-off valves of the well-known type are fixed.

The wash-out valves are usually 12in. in diameter, and discharge through lines of 15in. spun concrete pipes. Air valves are of the double ball type with a sluice valve or mushroom valve attached; a 1¼in. fullway cock is also provided. Where a summit is very near the hydraulic gradient, a steel upstand shaft, 10in. in diameter, is used in some cases, in place of air valves, and, as a further precaution against water hammer, there is a 4ft. upstand shaft at Culter. Manholes are placed at wash-out valves, air valves, &c., the average distance apart being about ¼ mile.

After a section of the aqueduct had been laid, it was tested throughout by water pressure. It was then emptied, and the ⅛in. clearance spaces between the pipes were cleaned out and caulked full of moist sand cement mortar. The water pressure test of each section was repeated at the end of the period of maintenance. The results of these tests were very variable. The best result in the case of a mile of 40in. pipe was 130 gallons leakage per mile per twenty-four hours under a pressure of 100 lb., but the average leakage was considerably greater than that. The measurements were made through small meters, but it is very difficult to eliminate air effects in flat sections.

Cults Pumping Station.

A 29in. cement-lined cast iron pipe leads water from the main aqueduct to the Cults pumping station—Fig. 6. The old steam pumping plant, which had been in operation for forty years, was scrapped. A new engine house was built and centrifugal pumps, actuated by electric motors, were installed. The capacity of the plant is 11·3 million gallons per day, but only one-half will be in operation at a time. Two pumps will each deliver 2·2 million gallons per day to the Slopefield reservoir, T.W.L. 308 O.D.; two pumps will each deliver 3·2 million gallons per day to the new Airy Hall reservoir, T.W.L. 242 O.D.; and two pumps will each deliver 0·25 million gallon per day to the Pitfodels reservoir, T.W.L. 402 O.D. The current is obtained from the Corporation electricity undertaking at 6600 volts and is transformed down to 400 volts.

Airy Hall Service Reservoir.

The Airy Hall service reservoir—Fig. 7 and Fig. 11, page 554—has a capacity of 7 million gallons. Its diameter is 290ft., and the average depth of water 17ft. It is constructed entirely in granitic rock of very variable quality. The concrete floor, which is sloped in parts to suit the hard rock surface, is 8in. thick. It is plastered and painted with three coats of sodium silicate. The walls were constructed in lengths in a manner similar to that employed for the storage reservoir. The roof piers are of mass concrete and the roofing is of reinforced concrete of the usual beam and slab construction. The roof is covered with 10in. of earth and is asphalted. The outlet pipe is 29in. diameter, and it joins on to an existing 24in. main which will become the leading main of a new distribution zone.

Conclusion.

The estimated cost of the scheme is £1,125,000, and the first instalment has cost a little over £1,000,000. The city entered on the scheme with the undertaking entirely free from debt; it was also fortunate in obtaining considerable grants from the Government. As a result, the water charges are still about the lowest amongst large towns. The works were designed by the city water engineer, Mr. George Mitchell, M. Inst. C.E., to whom we are indebted not only for the foregoing particulars, but also for the drawings and photographs from which the illustrations given herewith and on page 554 were reproduced.

A trial bore-hole which has been sunk near Glenely River, South Australia, in search for oil, has passed through several layers of sand impregnated with brown asphaltic oil. The gas pressure is said to be very high.

Models and Analogies for Demonstrating Electrical Principles.

No. XV.*

Antennæ models may be used either for teaching or research purposes, and especially for predicting those constants the knowledge of which is necessary for the proper designing of radiating systems for radio communication. For demonstrating the chief properties of antennæ it is unnecessary to use precise models. Simple models without supporting masts, but with rigid conductors able to carry their own weight, may be employed for the purpose. It is, however, useful to start the experiments with the prototype of all antennæ, a Hertzian oscillator of the form described, but without the cumbersome spark gap method of excitation. A Hertzian oscillator of this kind, consisting of a pair of telescopic tubes with spheres attached to them, can be made to radiate electro-magnetic waves, if properly coupled with a short-wave transmitter, as shown in Fig. 126 in the previous article. It is necessary that the length of the oscillator tubes connecting the centres of the spheres be adjusted to give resonance and placed parallel with the plane of the transmitting loop, because only in that position, when the direction of the magnetic field is perpendicular to this axis, can electromotive forces be induced along the oscillator. The currents induced in the oscillator when rotated around its bearing will vary from a maximum value, when it is in the horizontal position, to zero when it is placed vertically. This variation is indicated by a thermo-ammeter inserted in the centre of the oscillator. In order to excite the oscillator when placed in a vertical position, the loop of the transmitter must be rotated and also brought into the vertical direction. The distribution of current and voltage along a Hertzian oscillator is the result of two waves, one travelling from the centre towards the spheres, and the other reflected from the ends of the oscillator and rushing back to the centre. The value of the current is zero at the oscillator ends and achieves a maximum value in the centre. That this is the case can be shown by shifting the ammeter along the oscillator

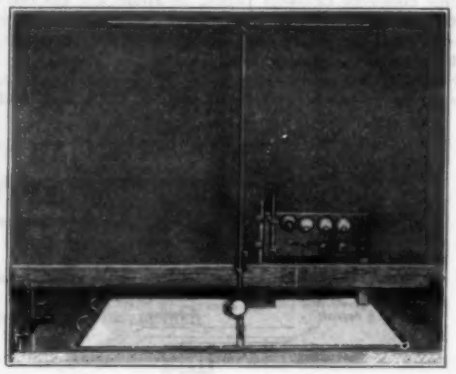

FIG. 129—MODEL OF "T" ANTENNA

so that the same length of tube is always shunting the instrument. Contrary to the distribution of current, the value of the voltage is maximum at the ends and zero in the centre. The distribution of voltage along the oscillator can be investigated by a method similar to that indicated for the transmitter and wavemeter bridge; or another oscillator in the form of a rod held at the centre can be coupled to that under investigation and the influence of its position upon the indication of the ammeter inserted in the current antinode can be studied. If the rod is placed vertically to the oscillator and with one end in contact with it, the magnetic field of the oscillator cannot produce electric forces in the rod. Only by charging and discharging can the rod be excited. The charge which the rod takes up will be largest and the greatest amount of energy will be drawn from the oscillator at points having the highest potential. By shifting the rod along the oscillator a decrease of the oscillator current is observed. With the rod at the centre of the oscillator no appreciable change of current amplitude is observed because that point corresponds to a potential node. However, when the sphere of the oscillator is approached, the decrease of current becomes appreciable, and reaches a maximum at the end point where an antinode of potential is found. For a Hertzian oscillator made up of a thin rod of uniform thickness, so that the capacity and the inductance per unit of length is constant all over the oscillator, the distribution of current and potential along the oscillator is sinusoidal. If, however, a coil of comparatively large inductance is introduced in the centre, the current and potential distribution becomes linear, *i.e.*, the rate of current decrease is then constant in every section of the rod and the potential gradient along the rod also becomes constant. On the other hand, it can be shown that large spheres attached at the ends of the oscillator, increasing considerably the capacity of the system, cause the current to approach constant values in every section of the rod.

* No. XIV. appeared November 12th.

By means of a Hertzian resonator combined with a sensitive thermo-couple connected to a galvanometer, the classical experiments of Hertz to show the existence of waves in the space surrounding the oscillator can be reproduced.

To demonstrate the origin and the chief properties of antennæ, all that it is necessary to do is to replace one-half of the Hertzian oscillator—Fig. 126—by a mesh held rigidly in a frame clamped to a table—Fig. 129—and to substitute a rod for the other sphere. Thus a simple model of a T antenna is readily built. The antenna is also quite easily transformed into the inverted L type, as illustrated in Fig. 130. Mushroom-form and other types of antennæ can be reproduced in the same way by means of a

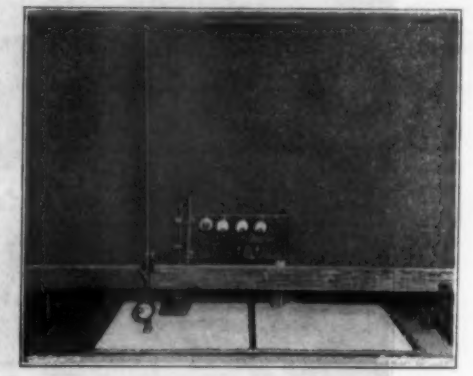

FIG. 130—MODEL OF INVERTED "L" TYPE ANTENNA

few rods and connecting pieces available in every school laboratory. The vertical rod of the antenna is supported by a board fixed to the table by means of clamps. The transmitter is placed in a vertical position so as to enable one to observe the measuring instruments. The following simple phenomena can be demonstrated with the models:—(1) Maximum current in the antenna is obtained when the transmitter is exactly tuned to the antenna; (2) the wave length of the antenna increases with the total length of the antenna, or with an increase in the number of rods at the top of the antenna; (3) the potential node of the antenna is situated at the point where the vertical wires are connected to the counterpoise frame. An insulated or earthed wire connected to this point does not affect the current indication of the antenna ammeter. The antenna current decreases if the wire is connected to any other point of the antenna system. The largest disturbance is produced by touching those parts of the antenna or of the counterpoise which are farthest away from the potential node. For purposes of experimental research more elaborate constructions of antennæ models are required. All those details of antennæ systems met with in practical construction which may have any influence upon the electrical characteristics have to be considered in the model. Thus the height and the material of the supporting structure, neighbouring dielectric or conductive masses, electric properties of the ground and other details may have to be taken into consideration.

One of the models used for investigations is illustrated in Fig. 131, which shows a model of a flat-top

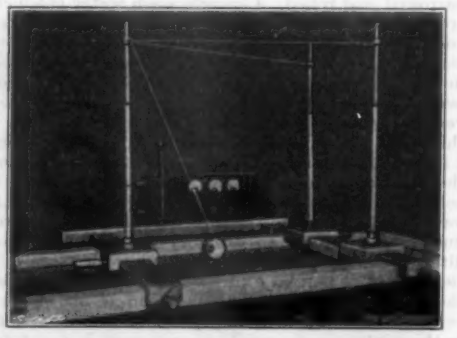

FIG. 131—MODEL OF THREE-MAST ANTENNA

antenna supported on three masts. The base of the model consists of a wooden frame supported on four legs. The frame, which is covered underneath with a copper sheet, forms a tray which can be filled with any material of the proper conductivity approximately to represent the properties of the ground. Cross pieces can be shifted and clamped by means of wooden screws in any convenient position along the frame. Carriages are arranged so as to be moved along the cross pieces and to be fixed in any convenient place.

These carriages have vertically-bored threaded holes to receive the bases of the standards serving to support the antenna wires. The number of cross pieces and carriages to be used depends on the number of masts employed for supporting the antenna wires. In the illustration two cross pieces and three carriages are shown with three masts. Hard rubber insulating pieces or rubber bands can be shifted along the masts

to set the antenna wires at any desirable height above the earth plate. Two antenna wires are visible in the illustration ascending from the ammeter towards the top of one of the masts, from which they diverge towards the top of the two other masts. The cross pieces have extensions, reaching 50 cm. beyond the frame, which are made to carry a baseboard for the short-wave transmitter. By moving this board parallel to the frame, the coupling of the transmitter with the antenna can be regulated. Finer adjustment of the coupling is carried out by means of the handle designed to rotate the plane of the transmitter loop. A similar model of a T antenna supported on two masts is shown in Fig. 132.

It is possible to determine the chief characteristics of every type of antenna by means of a model of the kind described. The fundamental wave length, the static as well as the dynamic capacity, the total and the radiation resistance can be determined, and from the values obtained by measurements, the inductance, the losses, and the efficiency of a given antenna can be

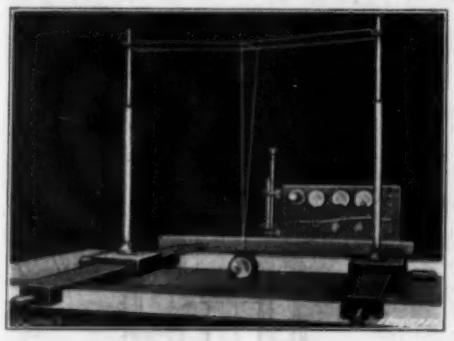

FIG. 132—MODEL OF "T" ANTENNA

calculated. However, the scale of the model is limited on the one hand by the space available, and, on the other hand, by the diameter of the wires that can be used for the antenna model. If the model is too large a special building is required to house the structure; if it is too small, wires of small diameter, possessing too small strength and introducing too large a resistance in the antenna circuit, become necessary. For antennæ corresponding in size to average ship antennæ, a model about $^1/_{50}$ to $^1/_{100}$ of the original may be used, but for the large antenna of a Transatlantic station a scale of $^1/_{250}$ to $^1/_{500}$ may be practical.

The methods of measurement employed in connection with the determination of antennæ constants are in principle identical with those used on full-sized antennæ, but the technique had to be modified and adapted to the use of short waves and stationary circuits. Care had to be taken to avoid errors due to the leads connecting the loading condensers, coils, resistance elements, ammeters, &c., with the antenna, and to diminish to a minimum the influence of the body of the transmitter and of the observer upon the antenna.

All the models dealt with in this article are described in Bulletin No. 147, of the University of Illinois, which was referred to in the previous article.

Coal Products, Chemical and Engineering Exhibition.

An Exhibition organised by the Manchester Section of the Society of Chemical Industry and dealing with the production of coal and chemicals was opened on Tuesday last at the City Hall, Manchester, by Captain F. W. Bain. Although not of a very extensive character, the exhibits give a good general impression of the part which coal and its products play in the chemical industry of this country. Originally it was intended to show the many processes to which coal is subjected after its arrival on the surface. Owing to the unfortunate coal strike, the original scheme had to be abandoned, and the organisers had to make shift with the sections of the industry which are not so seriously affected by the dispute. Special efforts have been made to demonstrate the nature of the research work which is being carried out in this country on our national fuel, and, considering this is the first exhibition of the kind which has been held, the organisers are to be congratulated upon the degree of success which has attended their efforts.

Although the Exhibition will be found to be of special interest to members of the chemical profession, there are quite a number of exhibits which will interest engineers. The increasing demand for oil and the approaching exhaustion of certain of the oilfields, should cause greater attention to be given to the oil shale, torbanite, cannel and other similar deposits which have hitherto been neglected. Perhaps one of the reasons for this is the difficulty in obtaining a suitable retort capable of recovering a paying percentage of oil. The Fusion Corporation, Ltd., Middlewich, has made what appears to be a very effective plant for this purpose, a model of which is on view on its stand. The chief feature of this retort is the horizontal setting of the tube which revolves by means of spur gearing. The material is fed into the retort by an automatic feeder, which is so arranged that whilst it is working the quantity of material being fed into it may be varied. Perhaps the most ingenious feature of this plant, however, is the breaking mechanism. The breakers are made in one or more lengths, and have three or more blades. They are not driven by any means external or internal, but are placed loosely in the retort, so that as the retort tube rotates the breakers keep falling over and over, and thus produce a chipping action which prevents the formation of scale on the walls of the retort, and break down lumps of material which would otherwise form. Owing to the fact that the edges of the breakers fall on to the bed of the material under treatment, the retort is very silent in action, and wear and tear is negligible. At the discharge end of the retort tube is a chamber which acts as a receiver for the residue or for the material after treatment. The connections to the condenser are also coupled to this chamber, through which the gas and oil vapours pass off. Another remarkable feature about this retort is the manner in which the granular material flows in a horizontal plane, this being effected by the material at the feeding-in end being of slightly greater depth than at the discharge end, thus providing the necessary head for the flow of the material. The Fusion Corporation also exhibits samples of iron tubes of quite large diameter and sheets made by the Hutchins electrolytic deposition process for wrought and cast iron and steel scrap. An idea of the strength of these cylinders or tubes can be gained from a study of a 6in. cylinder made of pure iron of a thickness ·035in., which we are informed withstood a pressure of 820 lb. per square inch before a pin-hole was started at the bottom.

The British Road Tar Association, Victoria Station House, London, S.W., has a stand representative of the gas industry and by-product coking industry. The scientific side of road construction is represented by various kinds of apparatus used in the testing of tars, and samples of tar and aggregates, as well as sections taken from roads constructed of tar-macadam. The Association claims that British tar in combination with approved mineral aggregate, either in the form of tar-macadam or a top surface dressing, not only gives sufficient wheel adhesion to prevent skidding, but retains it whether the road be wet or dry, thus giving a non-skid surface under all conditions. It is also claimed that with an adequate supply of stone chippings as a top dressing, tar adds to the life of the road by the amalgamation of the tar and top dressing material with the existing road surface.

The scientific exhibits have been lent by the Department of Fuel Technology, Sheffield University; the Department of Scientific and Industrial Research; the University of Leeds; the University of Birmingham; the Lancashire and Cheshire Coal Research Association; and the Fuel Department of the Manchester College of Technology. The exhibits by the Sheffield University include a collection of cokes from various coalfields, while the coal section is intended to illustrate the formation of bituminous coal from vegetable *débris* through peat and lignite, and a resolution of bituminous coal by means of hand sorting, the action of solvents and regulated oxidation. The Department of Scientific and Industrial Research, amongst other features, shows a method for the measurement of the emission of smoke from boiler chimneys and specimens illustrating a study of the ash in coal and the fusion point of ash. The University of Leeds exhibit includes sections and specimens of coals and cokes from coal carbonised in the Corbet-Woodall carbonisation plant at the Leeds University. The exhibit of the University of Birmingham is supplied by the Mining Research Laboratory, which is financed by the British Colliery Owners' Research Association. The exhibits illustrate a research which has been carried out in this laboratory. The Lancashire and Cheshire Coal Research Association's exhibits depict amongst other features a complete investigation upon a coal seam. Typical specimens of low-temperature cokes from various kinds of coal are included. The Manchester College of Technology exhibit comprises two sections, one illustrating the testing of refractory materials, and the second showing specimens of coke prepared in various plants and polished to show their structure. Specimens of carbonised briquettes made from coal by simple pressure from a mixture of a highly swelling coal and a non-coking material are shown.

Amongst engineering exhibits, Meldrums, Ltd., Timperley, near Manchester, show several of their specialities, including a centrifugal pump and valves made of acid-resisting metal, a forced draught furnace front, as applied to Lancashire and other types of boilers, and a smoke prevention door for vertical and locomotive types of boilers. The Lea Recorder Company, Ltd., 28, Deansgate, Manchester, shows its well-known coal meter applied to chain grate stokers of the Babcock-Wilcox type, and for measuring coal consumed by mechanically fired Lancashire boilers. George Kent, Ltd., Luton, have a miscellaneous exhibit, including a Venturi recorder for measuring water, steam flow meters, a rotary steam meter, and a Venturi gas meter for measuring the total output of gasworks. The exhibits of Richard Klinger, Ltd., Southwark-street, London, include a range of seatless piston valves, which are already well known to readers of The Engineer. S. H. Johnson and Co., Ltd., Stratford, London, are represented by filter presses of various kinds. Filtrators, Ltd., Astor House, Aldwych, London, W.C., exhibits a plant for the non-chemical treatment of boiler feed water. The apparatus takes steam from any convenient source and consists of a cast iron cylindrical digester in which is supported a container holding uncrushed linseed. The action of the steam generates a colloidal emulsion, which is said to prove efficacious for the prevention of scale and corrosion in boilers, economisers and condensers; while it is also claimed that the apparatus will also effectively remove existing hard scale. Electroflo Meters, Ltd., Park Royal, London, N.W. 10, is represented by an electrically operated fluid flow meter suitable for the measurement of low and high-pressure gas, steam, water or other fluid. One of these meters is in operation with a Spencer-Bonecourt boiler on an adjacent stand. Other exhibits by this firm include distance temperature indicators and recorders and pressure indicators and recorders.

The Crosthwaite Engineering and Furnace, Co., Ltd., Yorkstreet, Leeds, shows a mechanical stoker and self-cleaning furnace. Bolton's Superheater and Pipeworks, Ltd., Stockport, has a number of exhibits, including full-sized details of the Bolton-Gray sectional superheaters, an expansion downtake for preventing leakage of cold air into the flues of Lancashire and other similar boilers, and a new boiler feed pump which pumps and heats feed water simultaneously by the waste heat of the exhaust steam. Thomas Broadbent and Sons, Ltd., Huddersfield, are represented by working models of centrifugal machinery as used in the chemical industry. Sir W. H. Bailey and Co., Ltd., Salford, have a miscellaneous exhibit, including air compressor, vacuum pumps, acid pumps, valves, &c. Baird and Tatlock, Ltd., in association with J. J. Griffin and Sons, Ltd., Great Ducie-street, Manchester, exhibit scientific apparatus such as calorimeters, oil testing apparatus, gas analysis apparatus, and electric pyrometers, &c.

The Exhibition remains open until Saturday, November 27th.

SIXTY YEARS AGO.

Sixty years ago the British Navy still possessed over forty unarmoured wooden warships. Some of these vessels, such as the three-decker line-of-battleships Howe and Prince of Wales, were not above six years old. Others, such as the two-deckers Prince Regent, Royal George, Bombay, Neptune, Royal William and Rodney, dated from the 'twenties and 'thirties, while at least one line-of-battleship, the Nelson, had been built in the year of Waterloo. They had all, or nearly all, been built for or converted to steam propulsion, but the advent of the Warrior in 1860 and the development of the ironclad in the following years had rendered all our unarmoured wooden vessels obsolete. They were still, however, maintained at considerable expense in sea-going condition. Public opinion was against their retention, and it was advocated by many that all our obsolete vessels, instead of being allowed to encumber our ports and harbours, should be broken up. Some people, among whom apparently we must number ourselves, were opposed to their destruction. In our issue of November 16th, 1866, we advanced the view that with one exception the worst thing we could do with our old line-of-battle ships was to break them up. The exceptionally worse use would be to employ them as they were in any important operations of naval warfare. We argued that the proper course to pursue was to convert them to armour-plated vessels. At least two-thirds of the old fleet consisted of ships that were structurally sound. Their soundness, we stated, was the outcome of the infinite pains and thought expended on their construction. The frames had been made from the soundest timber that money or skill could procure or select. When set up the frames had been allowed to remain uncovered by the skin for from two to six years, and from time to time during that period had been examined, every defective piece found being removed and replaced by a fresh piece of timber free from decay. As for the conversion, it was argued that below the water line the ships of the old fleet were in all respects as satisfactory in design and construction as the ironclads of recent years. It was only as regarded their above-water structure that they had become obsolete. It was therefore proposed that the upper decks of the old ships should be cut down and that 1½in. armour plates surmounted by 18in. of teak, and finally by 6in. or 8in. armouring, should be worked on to the existing sides down to and below the water line. On the original remaining deck turrets would be mounted, each containing two 22-ton guns. The working of the ship under sail was to be facilitated, and the strength lost by cutting down the original decks restored by the construction of an iron deck over the tops of the turrets. This deck would be supported by diagonal box trussing, and would extend from the poop to the forecastle. Such a scheme, advanced by Mr. C. F. Henwood, the manager of one of the largest shipbuilding firms in the country, was, we stated, at that moment receiving the consideration of the Admiralty. We put the cost of converting a ship on Mr. Henwood's plan at £75,000 to £110,000, as compared with the estimated cost of £260,000 for the "Captain"—Captain Cowper Coles' ill-fated vessel—then under construction.

THE BRITISH ENGINEERING STANDARDS ASSOCIATION.

At the annual general meeting of the British Engineering Standards Association, recently held, Sir Archibald Denny, the chairman, in a short statement to the members reported that whilst the general work of the Association was in a most healthy condition, the finances, he regretted to say, were not. It could not, of course, be expected that this industrial work would be unaffected by such a devastating cessation of activity as the coal strike, and the Association had done its utmost to introduce still further economies in addition to taking precautions for the immediate future.

He regretted that on March 31st last the Association had to face a total deficit of just over £2500. This implied that for the time being, at any rate, the Association could not give effect to the expansion which should and would naturally take place if the necessary funds had been at its disposal. With the help, however, of the Ways and Means Committee, the needs of the Association were being more prominently and more systematically brought to the notice of many firms, public supply authorities and others. The scheme of membership which was mentioned last year had been put into operation, and was proving moderately successful, there being now some 600 members enrolled.

The report showed that the work of the various sections is being maintained, attention being specially concentrated on the more important inquiries. One of the sections of more than ordinary interest at the moment is the colliery section, the work of which is financed by the coalowners. It will be remembered that in the report of the Royal Commission it was stated that the work which the Mining Association had recently set out to do, under the ægis of the B.E.S.A., is perhaps the most important general inquiry in which the industry has in recent times been engaged, and it should yield valuable gains in efficiency and economy. Amongst other matters, the question of the reduction of the number of varying types of rails in the coal mines has been the subject of a most elaborate inquiry, resulting ultimately in a recommendation to reduce the present thirty-eight sizes, with twelve or more sections, down to a total of fourteen. With the gradual adoption of these British standards throughout the coalfields, large economies are bound to result.

The question of international collaboration in standardisation work has recently come under the consideration of the Association, and is being carefully explored.

Two-stroke Double-acting Marine Oil Engine.

An important share in the development of the marine oil engine in Germany has always been taken by the Fried. Krupp Germaniawerft, of Kiel-Gaarden. Prior to 1914 and during the period of the war that firm was noted for its submarine oil engines, while experimental work was carried out by it on the construction of oil engines for battleship propulsion. The post-war development work has of necessity been confined to engines for land work and for commercial ships. In 1920 the motor tanker Zoppot was engined by Krupps with a six-cylinder 1675 brake horse-power motor working on the two-stroke single-acting principle, and fitted with valve scavenging. That engine to date, we learn, has done good service. The later Krupp designs have, however, tended in the direction of two-stroke motors, with port scavenging, a type of engine which is simpler to construct and is less costly. The firm has built single-acting engines of this type in multi-cylinder units, but for horse-powers above, say, 2500–3000 the double-acting design possesses considerable advantages, both as regards reduction in weight and in cost. With a view to testing a large-sized cylinder of the latest design, the single-cylinder unit, which we illustrate by Figs. 1 and 3, was built. Since March last the engine has been under continuous test and observation, and it has given, we understand, very satisfactory results. In what follows a description of this new marine motor will be given.

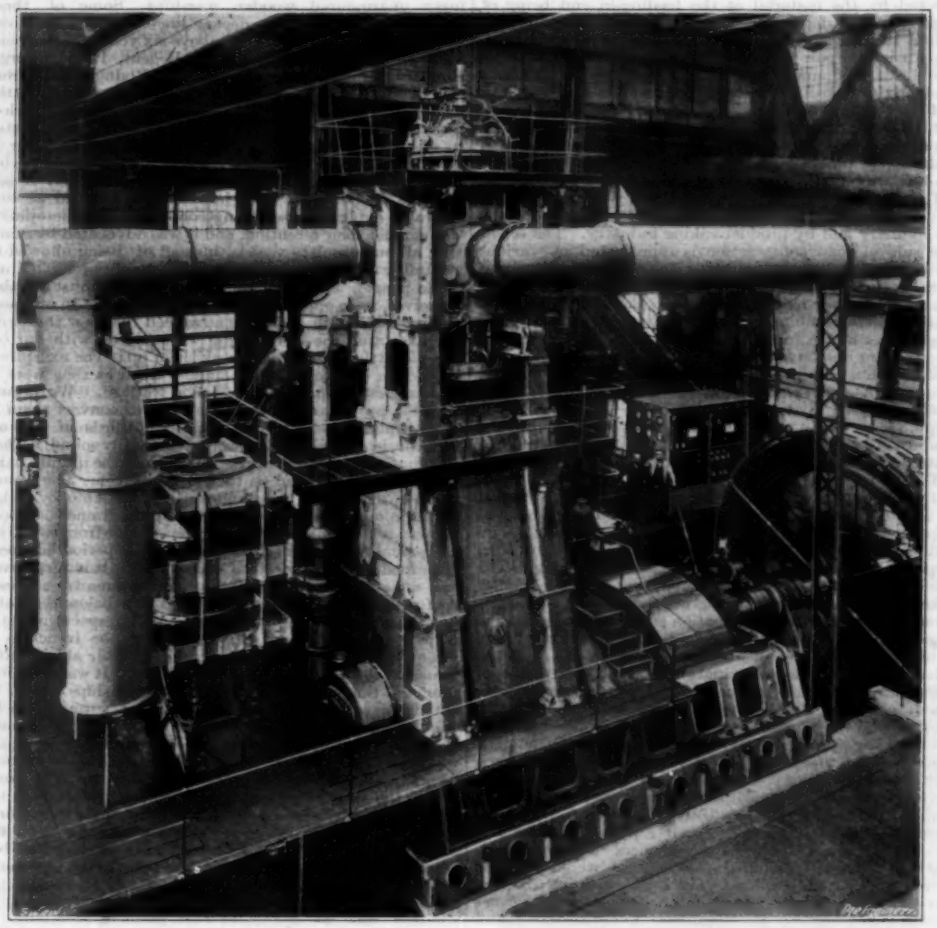

FIG. 1—1800 H.P. TWO-STROKE DOUBLE-ACTING MARINE OIL ENGINE

A 1800 Indicated Horse-power Test Unit.

The view we reproduce in Fig. 1 shows the engine on the test bed, when running at its full designed speed. It has the following principal dimensions and particulars :—

Total designed output	1800 I.H.P.
Cylinder diameter	800 mm.
Piston stroke	1500 mm.
Normal speed	85 r.p.m.
Height from centre of crank shaft top to of fuel valve	9½ metres, or 31ft. 2in.
Fuel consumption per I.H.P. hour..	144 grammes, or 0·316 lb.

From the sectional drawing reproduced in Fig. 3, some details of the design may be gathered. Special features have been introduced with the object of securing ready accessibility and at the same time retaining simplicity in construction. The bed-plate, as will be seen from Fig. 1, is built up for a three-cylinder engine and the two remaining sets of cylinders are to be added at a later date. It is formed of longitudinal and transverse members secured by fitting bolts and underneath it a cast iron oil sump is attached. The main columns, which carry the cylinder casing, are made in three sections. The first section is rather short, and it terminates a little below the crosshead guides, which are carried by the second section, while the third section has an open column structure, which gives access to the lower cylinder valves and the piston-rod stuffing-box. The two sets of lower columns are of the usual A pattern, and the space between them is enclosed by light steel doors—see Fig. 1—which can easily be removed. By making the crank case columns in two pieces it is possible to take out a section of the crank shaft by removing the lower columns, without having to dismantle the upper portion of the engine. The crank case is completely enclosed at the top, and is provided with an oil-tight tray, so as to ensure that the lubricating oil within the casing is not contaminated by oil which otherwise might pass down from the working cylinder. A special feature of the Krupp design is the manner in which the cooling water pipes for the piston are carried well outside the crank case. The arrangement will be clearly seen in the sectional drawing Fig. 3, and Fig. 2 shows the piston-rod crosshead unit with the steel frame to which the pipes are attached. All the cooling water pipes with their telescopic connections are enclosed in a vertical casing, which is furnished with a glass inspection door. This casing is arranged at the front of the engine, as shown in Fig. 4. The same view also illustrates the fuel pump unit, with the speed regulating lever, the governor and the vertical shaft drive to the horizontal cam shaft, which is placed on a level with the cylinder casing and can be seen in the lower part of Fig. 6.

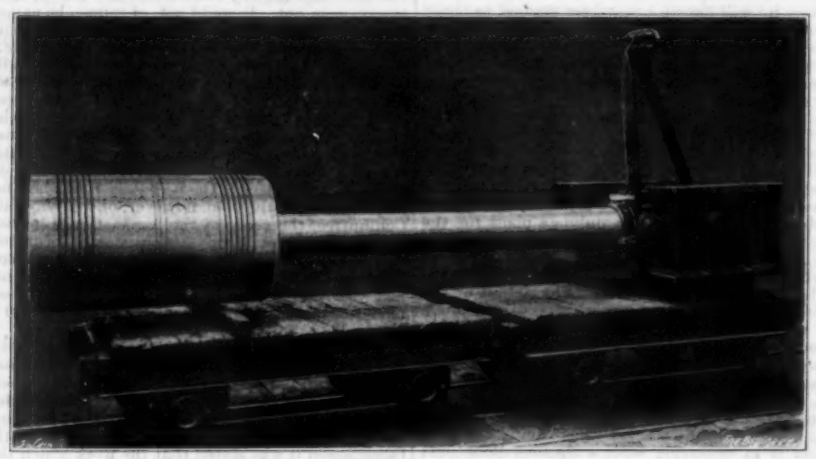

FIG. 2—PISTON AND CROSSHEAD

Cylinder Casing and Cover.

The main cylinder casing, which is attached directly to the columns, carries the centre section of the three-part cylinder liner, in which scavenging and exhaust passages are formed on opposite sides of the cylinder walls. The upper and lower sections of the liner are alike in design and of a plain shape, so that these parts which are most liable to wear can be replaced without great cost. They are kept in position by the cylinder covers, which also hold those parts of the cylinder casing which form the liner cooling spaces around the working cylinder. The design is so carried out that all the cylinder forces are carried by the central part of the cylinder casing and liner, and are transmitted to the main columns and bed-plate by the through-going stay bolts. These bolts are divided into two sets, the upper bolts fastening the cylinder casing to the top of the vertical columns and the lower bolts securing these columns to the bed-plate. The lower bolts are to be clearly seen just below the lower platform in Fig. 5. The upper and lower cylinder liners have only to withstand the combustion pressures, and they are free to expand in a longitudinal direction. The top cylinder cover presents some new features. It is made in two parts, the conical cover proper, which contains the fuel valve and the starting valve, and an additional outer clamping ring. In accordance with the usual Krupp practice a shallow water-cooled chamber is arranged just inside each of the cylinder covers, so that the main covers are not exposed to the full heat of the combustion gases. The bottom cylinder cover is furnished with two horizontal fuel valves, which are so disposed that the fuel is injected tangentially into the cylinder. A starting valve is also fitted in this cylinder space. As will be seen from Fig. 3, the valves are operated by horizontal and vertical push rods from the horizontal cam shaft, which is driven by skew gearing from the main crank shaft.

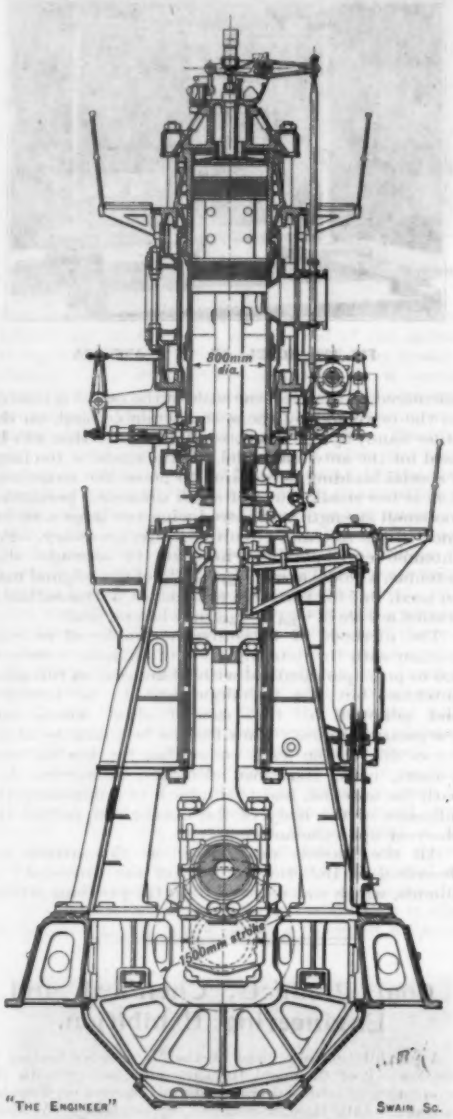

FIG. 3—VERTICAL SECTION THROUGH CYLINDER

The manner in which the lower cylinder cover and casing can be removed downwards in order to give access to the piston is shown by Fig. 5. It is claimed that this operation can be performed with simple lifting rig and the piston changed within a very few hours of shutting down

the engine. A point of interest, both for the testing and running of the engine, is illustrated by Fig. 6. In the scavenge air main at a position opposite to the air ports in the working cylinder, a glass window of the porthole type has been inserted. It gives a clear view right through both sets of scavenge air and exhaust ports. In the view given the steel cover plate which is mounted on the front of the scavenge main in order to carry the observation window is clearly shown. The window itself is hinged, and is secured by two locking screws. At the time the photograph was taken the scavenge chamber was specially illuminated to show the bars between the ports in the cylinder liner.

When the engine is running it is claimed that this device enables any defect in scavenging or incomplete combustion quickly to be detected, as such a defect becomes at once apparent by the smoky appearance of the air immediately behind the observation window.

An Oil-operated Fuel Valve.

Although, as shown in the accompanying illustrations, the fuel valves on the test unit are mechanically controlled,

FIG. 6—OBSERVATION WINDOW IN SCAVENGE-AIR MAIN

Messrs. Krupps have recently made experiments with a new hydraulic control system, which may later be applied to the double-acting engine, and when fitted would effect a considerable further simplification.

The working principle of this new type of fuel valve control is illustrated diagrammatically by Fig. 7. Just before the piston reaches the end of its stroke, the fuel pump delivers oil to the fuel valve at a high pressure. The oil is divided into two streams immediately in front of the fuel valve, one part operating a plunger and rocker bar which lifts the needle valve, and the remaining part being delivered direct to the fuel valve casing in the usual manner. When the needle valve is lifted the oil is injected into the working cylinder by compressed air, but as soon as the supply of fuel from the fuel pump is reduced in pressure the needle valve closes and both the injection air and the fuel are cut off from the cylinder. The makers claim that this new type of oil-operated valve effects a considerable saving in the amount of injection air which is used when the engine is running at low speeds. The time of opening of the fuel valve is also diminished, and the early stages of combustion are not interfered with by the undue cooling of the cylinder by the injection air. It is stated that on tests made with this new valve a fuel consumption of 131 grammes, or close upon 0·30 lb., of oil per indicated horse-power hour has been attained with a mean effective cylinder pressure of over 100 lb. per square inch; with an overload of 26 per cent. on the experimental engine with which this valve was fitted,

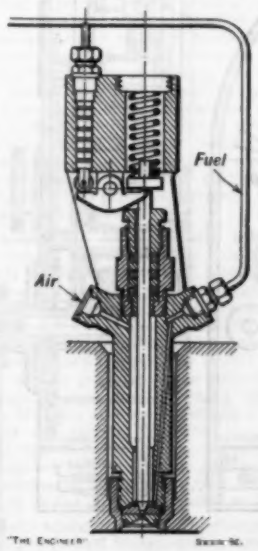

FIG. 7—OIL-OPERATED FUEL VALVE

the consumption rose to 141 grammes, or a little over 0·31 lb. per indicated horse-power.

Test Bed Arrangements and Results.

As will be seen by reference to Fig. 1, the engine is coupled direct to a fly-wheel type alternator, and the usual provision for measuring the fuel oil, injection air, scavenge, air, cooling water, &c., is made. To the left of the engraving is the reciprocating scavenge air pump, with its coolers and duplicate air reservoirs. This pump, the makers inform us, is one which has been used for some time for testing purposes in the works; but that it is somewhat large and bulky for the purpose for which it is required, and in the actual installation aboard ship the scavenge air will be supplied by electrically driven turbo-blowers.

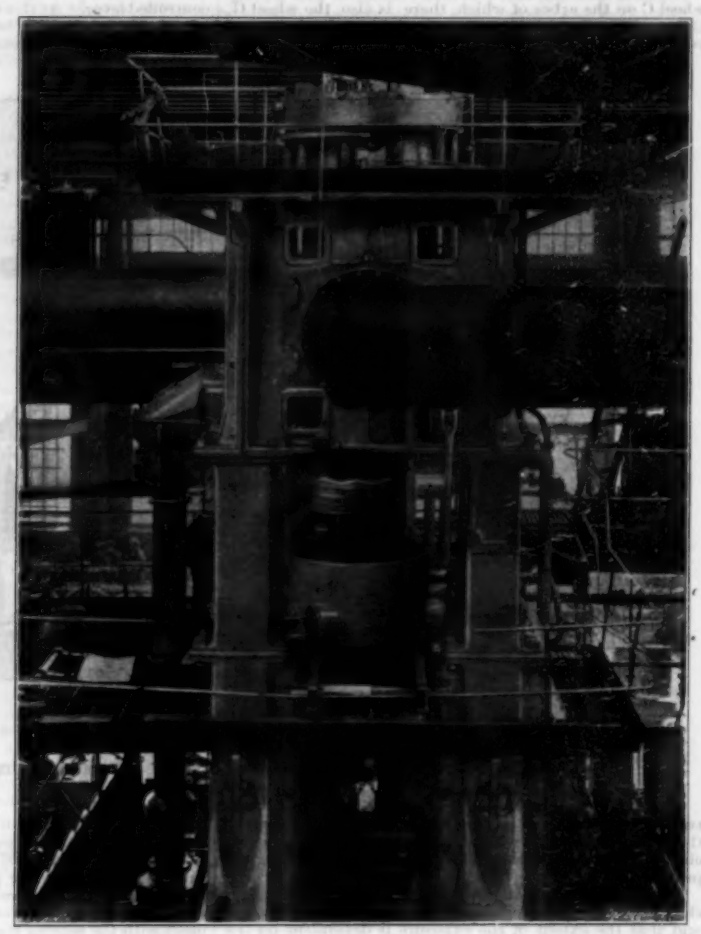

FIG. 5—VIEW SHOWING LOWER CYLINDER COVER DISMANTLED

The tests which have been made since the engine was started up have totalled altogether more than 800 hours, of which a little less than half has been devoted to overload tests at 10 and 15 per cent. overload. The results obtained were, we are informed, uniformly satisfactory as regards combustion and reliable working on both the top and the bottom sides of the piston. It is anticipated that it will be possible to rate engines in actual service at 85 to 88 per cent. of the full output which was obtained during the continuous test bed runs.

The engine we have described will shortly be completed as a three-cylinder unit, with a total designed output of about 5400 indicated horse-power at the normal running speed of 85 revolutions per minute. The total length over the three-cylinder unit, including the fly-wheel outboard bearing and compressor, will not exceed 12 metres, or, say, 39ft. Such an engine will only require a comparatively short engine-room, and it is estimated that in a vessel of the Asturias class, a twin-screw arrangement of nine-cylinder engines of this new type could easily be accommodated in an engine-room of 26 to 27 metres, or about 85ft. to 89ft., in length. The machinery would be designed to give the vessel a service speed of about 20 knots.

An Aerial Mapping Camera.

No. II.*

In our previous article we gave an outline of the characteristics of the camera made by the Williamson company, and marketed by the Vickers company, which has been specially developed for the production of photographs for aerial mapping purposes, and we now propose to give some account of the interesting mechanisms employed for working the camera automatically. It should be understood at the outset, however, that we do not intend to deal with the whole apparatus exhaustively, but rather to describe only those parts involving novel ideas. The extent of the full equipment may be gauged by a glance at Fig. 3, which represents a camera with all its accessories.

In this view the camera proper is shown at A. B is merely a protective cover to take the place of the film magazine. C is the electric motor for driving the machine, and D the alternative driving windmill. Either of these motors can be connected with the main "gear-box" E by means of flexible shafts, and they provide a simple rotary motion. The various intermittent functions of the camera, such as film winding, shutter exposure, &c., are all controlled by apparatus in the case F. G is a simple manual release for the shutter, and H is the warning red light for the pilot, to which reference has been made already. In the following notes attention is concentrated on the devices E and F, as the constructive details of the remainder can be easily imagined.

The gear-box—of which we give a line drawing in Fig. 4—is a separate unit in itself, and can be readily detached from the camera body. Within it there is all the mechanism necessary for operating the magazine, the shutter, a Veeder counter and for switching on the lights for photographing the recording instruments. The power necessary

* No. I. appeared November 12th.

for operating the gear is, as already mentioned, provided by the motor or the windmill, either of which is connected with the worm spindle A—Fig. 4—by means of a flexible shaft. In a case of emergency the handle shown plainly in the side view can be used to drive the gear manually. The worm, it will be seen, drives a train of wheels, of which B may be described as the main drive of the whole mechanism.

Meshing with the main driving wheel there is another wheel C on the arbor of which there is also the wheel G. C transmits the drive to the wheel D, and, through a corresponding wheel on the same spindle as D, works the

FIG. 3—AERIAL MAPPING CAMERA AND ACCESSORIES

two pinions E and F of the exposure shutter. Behind the wheel G there is what might be described as a dog clutch H for winding the sensitised film and operating the pressure plate.

It may be as well, at this point, to recall the fact that the shutter is spring-operated for making the exposure, and that the extent of the exposure is dependent on the tension of the spring. The function of the gear-box is to reset the shutter by winding up the spring again, but to leave it completely free to fly back so soon as it is released by the distant control F—Fig. 3.

The speed of the motor driving the worm A is, of course, no criterion of the interval between the exposures, and it will, as we have already stated, complete a cycle in 4½ seconds, while the exposures may be required at intervals of as much as a minute. It consequently becomes necessary for the wheel C—Fig. 4—to stand stationary, after the resetting, while the main drive B goes on rotating. This requirement is provided for by making the train of wheels such that almost one revolution of C will complete a resetting. Then, by cutting away a few teeth on the wheel C, there is provided a free space in which the main driving wheel B can rotate without driving the gear. In order to facilitate the re-meshing of the gears when the next cycle has to be performed, the first tooth, on the wheel C, is made as a loose piece, slideable radially under the influence of a spring, so that it may give way if it encounters the top of a tooth on B, and allow the next tooth to take up the drive.

When the wheel C has been turned through a full revolution it is brought up definitely by the catch J meeting a stop fixed on the casing. At the same time the roller K, on the wheel, is caught by a projection L on a spring-controlled lever. At this stage in the operations the camera is completely reset. The film has been wound forward by the clutch H, the pressure plate has been pushed down on the top of the film, to keep it in intimate contact with the glass, and the two parts of the shutter have been rewound by the pinions E and F. The main blind of the shutter is wound by the pinion E, while F works the capping blind which obscures the slit during rewinding. The two wheels D, the rear one of which cannot be seen, that mesh with the pinions E and F, have a few teeth cut away in appropriate parts of their circumference, so that when the compound shutter has been drawn right across the aperture, in rewinding, the pinion F is released and the capping blind flies back to the starting point. The pinion E is also released immediately afterwards, but the blind is held by the pawl P, the object of which will be described immediately. The exposure is then made, as follows, by the distant control F—Fig. 3.

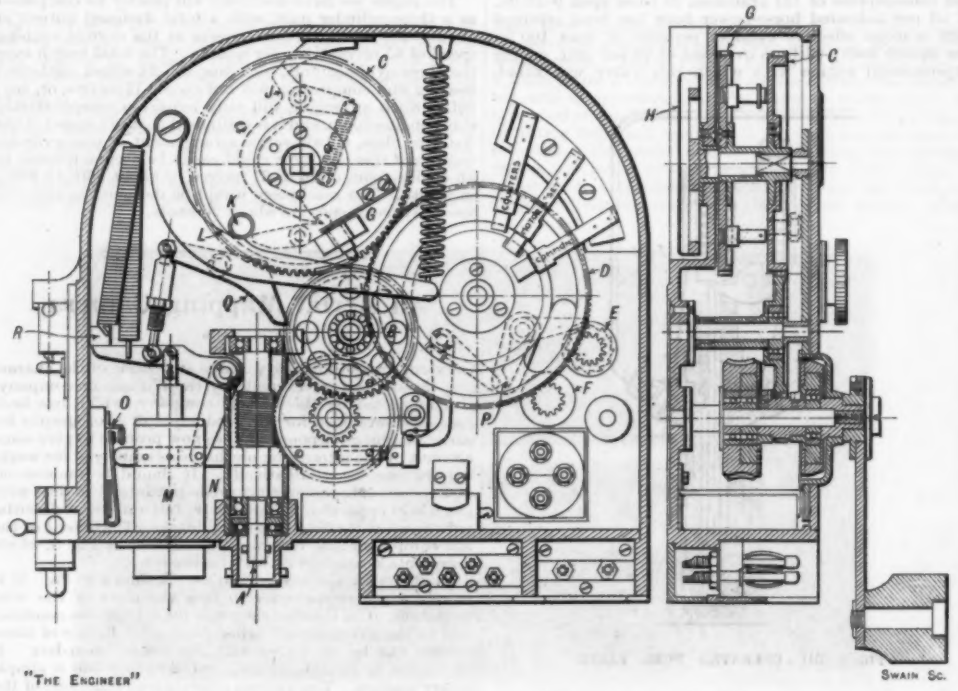

FIG. 4—SECTION THROUGH CAMERA-OPERATING GEAR-BOX

The solenoid M is energised and moves the bar N towards the right. This first closes the switch O, which illuminates the instruments in the instrument box; it then trips the pawl P, to release the main shutter, and finally releases the catch J, by means of the rocker Q. So soon as the catch J is free the spring pressure between the projection L and roller K gives the wheel C a push forward, and it comes into mesh with the main drive B again, so that the whole cycle is repeated. The manual control for taking separate photographs is a simple Bowden wire connection from G—Fig. 3—to the pusher block R—Fig. 4—which acts on the trip mechanism in the same manner as the solenoid M.

It will be noticed that in connection with the gear wheel D there is a set of electrical wipers, working on appropriate rings. The upper one controls the counter, which shows the number of exposures that have been made, the next is in the circuit of the driving motor and also in that of the indicator for showing that the camera is reset, while the third is a common return. In the case of the wiper in the motor circuit there is a little gap cut in the ring at a point corresponding to the position at which the wheel C comes to rest, so that the motor is then stopped and the current correspondingly economised; but the circuit is immediately re-established when the projection L pushes the roller K and wheel C forward.

The remote control—F of Fig. 3—is also shown in Fig. 5, with its cover removed. It is connected with the gear-box by means of two flexible cables, one with three leads and the other with five, fitted with plugs and sockets of such design that the connections can be made only in the proper manner. It has three outside controls—the switch on the left and at the top for switching on or off, the button marked "Press" below, for taking snapshots, and the knob in the centre for setting the interval between automatic exposures.

The main switch at the top needs no comment, while the "Set" indicator below is a simple device, as is also the pressbutton. At the top on the right there is a counter which is operated by the left-hand solenoid below when the circuit is completed by the contacts in the gear-box. The dial marked "Seconds" is really the face of a simple spring-loaded clock mechanism, which is periodically rewound

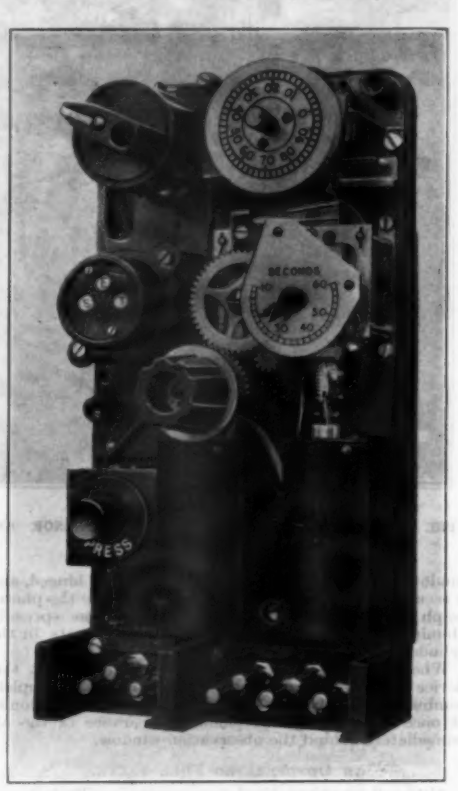

FIG. 5—REMOTE-CONTROL APPARATUS

by the solenoid below on the right. This clockwork carries round one part of an electric contact in the circuit of the tripping solenoid in the gear-box. The other part of this contact is connected mechanically with the central knob, and can be moved round so that its angular advance over the contact driven by the clock can be varied over fairly wide limits. Pointers are connected with the two parts to show their relative positions. It is obvious, that with this arrangement, by setting the adjustable contact further in advance of the running contact, a longer period of time will pass between successive exposures, and that the period is always under control. Within the control box there is also the contact gear for working the warning lamp—H, Fig. 3—in the pilot's cockpit.

From the foregoing notes it will be seen that although, at first sight, it might seem a simple matter to devise a mechanism to make successive photographic exposures, the realisation of that requirement has involved a large amount of ingenuity when flying conditions have to be contended with. Again, our inspection of the camera itself shows that the manufacturers must have taken great pains to produce a robust apparatus, which is also easy to maintain.

In our issue of December 9th, 1921, we had an article on signal posts and telegraph poles of reinforced concrete instead of wood. From the president's address of the Institution of Railway Signal Engineers, now available by the publication of its proceedings for the first half of 1926, it seems that in 1918, with the object of providing a structure capable of withstanding wind and snowstorms, ferro-concrete poles, fitted with angle iron truss supports for the insulator fittings, were put into service on a very exposed section south of Peterborough on the Great Northern main line. South thereof a mile of wooden poles, similarly fitted, were erected. Both have withstood severe storms. It is anticipated that the truss fittings and stays reduce the tendency to breakage of wood poles above the ground line.

Railway Matters.

On Thursday, November 4th, there was a collision, involving an express passenger and a milk train between Farnborough and Fleet on the Southern Railway. The accident is of interest inasmuch as that section of the line is protected by automatic signals. The driver of the passenger train has since died from the injuries he received.

During the floods that resulted from the severe storms in the North of England a fortnight ago the viaduct on the former Furness Railway over the Duddon Estuary was damaged and all traffic had to be suspended. The bridge was, however, subsequently sufficiently repaired to permit working over a single line of railways being put into operation on Wednesday, the 10th.

A table presented to the Safety section of the American Railway Association shows that last year 6766 persons were killed and 137,435 injured on American railways, and that the amount paid in compensation for personal injuries was 45 million dollars. The cost of clearing the wrecks was 8 million dollars; of damage to rolling stock, 50 millions; and of damage to the track, 15 millions. The total cost of accidents was therefore 118 million dollars, or 2·51 per cent. of the total operating expenses.

The Southern Railway Company maintains a ferry service between Lymington—the terminus of the Brockenhurst-Lymington Branch—and Yarmouth in the Isle of Wight. The pier at the former place is in the river Lymington, the dredging of which should be done by the local authorities. That work not having been efficiently maintained, it has been taken in hand by the railway company, which has issued a notice that as the dredger occupies a large portion of the fairway, the ferry has had to be discontinued after dark.

The Ministry of Transport railway statistics for August last, just issued as a Stationery Office publication, shows that when compared with the corresponding month of 1925, there was a falling off of 17 per cent. in the number of passenger journeys and of 16·1 per cent. in the receipts from passenger fares. The decrease in receipts from all passenger traffic was 14·3 per cent. As a set off against that, the passenger train mileage was reduced by 8·5 per cent., but that was not as good a result as that achieved in July, when, with 19·7 per cent. fewer passenger journeys, the mileage was lowered by 21·3 per cent. The total tonnage carried fell by 50·5 per cent., which mainly was caused by a drop of 72·7 per cent. in mineral traffic. Freight train receipts were, however, only 28·9 per cent. down, and the freight train mileage was reduced by 32·3 per cent. In July those two figures were 43·1 and 41·5 per cent. respectively, which, with the present figures, show that the companies are suiting the freight-train expenses to their receipts.

Considerable interest has been aroused in the United States recently by the centenary of the opening of the first railway in America. It is the second centenary celebration this year, but in the first the New York Central commemorated only the granting of a charter. The railway that was opened on October 7th, 1826, was from Quincy, just outside Boston, Mass., to the Neponset River, for the purpose of conveying granite to build the Bunker's Hill monument. The line was of the "way-leave" or wagon-way type, very much used in this country long before the opening of the Stockton and Darlington Railway. In fact, if we had to commemorate the opening of the first such line as the granite railway, it would be of that built by Huntingdon Beaumont between Wollaton and Strelley to the river Trent at Nottingham. It was opened about the end of the sixteenth century—about 1597. It is gratifying to know that the greater part of the original route of the first American railway is still in use. It is owned by the Granite Railway Company, and is worked by the New York, New Haven and Hartford.

On March 7th last there was a buffer stop collision at Brighton Station, on which Major Hill held an inquiry, and his report was noted on page 90 of our issue of July 23rd. A similar collision happened on July 18th, which also was inquired into by the same officer, whose report on it is now available. In both instances the mishap occurred on a Sunday, which was a contributory cause to each accident, as the drivers were running trains and entering roads to which they were not accustomed. In the later collision the driver is said by Major Hall not to have known the station very well; in fact, he had only had two turns of a week each which included the driving of trains into Brighton Station. That fact was the key to the accident. He was entering No. 7 road, the buffer stops of which are 40ft. nearer an approaching train than those in the adjoining No. 8 road. He had the latter line on his left, and was watching its buffers in ignorance of the 40ft. difference. It was agreed that had the roads been the same length the train would have stopped short of the buffer stops. Major Hall recommends that a marker board, opposite the buffer stops in No. 7 road, be erected between Nos. 7 and 8 platform lines.

According to the Board of Trade returns the value of the railway material exported during the first nine months of the present year was as follows; the corresponding figures for the nine months of 1925 and 1924 are added in brackets: — Locomotives, £2,525,335 (£2,184,503, £1,491,348); rails, £1,287,387 (£1,456,600, £1,273,257); carriages, £2,206,039 (£1,148,307, £877,147); wagons, £2,329,251 (£2,545,456, £2,574,954); wheels and axles, £369,172 (£452,842, £446,453); tires and axles, £221,304 (£320,609, £474,322); chairs and metal sleepers, £611,153 (£686,465, £959,805); miscellaneous permanent way, £850,727 (£1,005,551, £853,700); total permanent way, £3,485,572 (£4,067,738, £4,170,375); the weight of the rails exported was 160,359 tons (154,616 tons, 138,169 tons); and of the chairs and metal sleepers, 62,988 tons (61,390 tons, 76,242 tons); the locomotives sent overseas during the month of September last were of the value of £90,385, and they included the following:—Other countries in South America than the Argentine, £51,604; Ceylon, £14,388; India, £1885; South Africa, £1747; and the Argentine, £1326. The value of the rails exported in September was £51,135, and included:—The Argentine, £21,618; India, £7438; South Africa, £4704; New Zealand, £2589; and British West Africa, £1021.

Notes and Memoranda.

Iodine is obtained in Java in a liquid condition from natural sources, found principally in the Soerabaya Residency. The yearly production has been between 20,000 kilos. and 30,000 kilos., but for 1925, writes the United States Assistant Trade Commissioner at Batavia, it was estimated at approximately 60,000 kilos. of pure iodine. Exports abroad consist for the most part of copper iodide, the principal buyer being Great Britain. In 1924, exports of copper iodide amounted to 89,900 kilos., or nearly 200 per cent. more than in 1923.

In the course of a paper read before the South African Institution of Engineers, Mr. R. Craib said that the pumping plant at the Simmer and Jack Gold Mine comprises 15-stage Sulzer high-lift pumps, in two sections, with 2000 horse-power S.A.G.E. Co. motors mounted between, the synchronous speed being 1500 revolutions per minute. These units deliver 75,000 gallons per hour against a manometric head of 3256ft., which the author suggests is probably the highest lift of any pump in the world. The rising main is 10in. in diameter, and has no expansion joints.

From 1859 to 1924 approximately 661,679 wells were drilled for oil and gas in the United States, of which 129,875, or 20 per cent., were dry holes, states the Bureau of Mines in a recently issued report. In 1924 the number of wells drilled for oil and gas in the United States—exclusive of dry gas wells and dry holes in California, for which figures are not available—was 21,888, which was 2550 less than in 1923 and 12,023 less than in the record year 1920. Of the total number of wells drilled in 1924, 67 per cent. were oil wells; 10 per cent. gas wells; and 23 per cent. dry holes.

Experiments carried out in America have shown that by using an artificial atmosphere of oxygen and helium during the decompression of a diver, the decompression period can be reduced to one-third, or one-fourth, of the time necessary with air. The advantage of helium arises from the fact that it is only about half as soluble as nitrogen, and thereby greatly reduces the amount of excess gas that a man will accumulate while under pressure, and that will have to be given off in decompression. Also, because the helium molecule is smaller than nitrogen, it will diffuse more rapidly, and the escape of the excess gas will be facilitated.

In the course of a paper on "Oil Fuel," read before the Institution of Petroleum Technologists, Dr. F. Mollwo Perkin said that his opinion is that the retort of the future will be vertical, heated externally and also internally by passing a portion of the thoroughly scrubbed gas up through the retort. The gas becomes heated by passing through the carbonised material at the bottom of the retort. This helps to cool the coke and the heat taken up by the gas will assist in the carbonisation of the coal as it descends and also carry off the volatile matter more rapidly, thus preventing oils condensing on the cold material at the top of the retort and being decomposed.

The British Commercial Counsellor at Rome reports that, according to officially published figures of the latest census of the number of hydro-electric stations—over 300 nominal horse-power—in operation in Italy at December 31st, 1925, there were 588 with over two million nominal horse-power capacity. At the same time 95 stations, with about one million nominal horse-power, were under construction. The reservoirs utilisable for the production of power were 86, with a total capacity of over 800 million cubic metres, representing a nominal reserve, when full, of 1300 million kilowatt-hours. The effective value of this reserve in connection with existing plant is estimated at 650 million kilowatt-hours.

For the purpose of increasing the yield of the oil from wells at Elliott Pool, Oklahoma, a mixture of air and natural gas is pumped down adjacent wells. In order to localise any explosion, which might occur in the piping, there are arranged "explosion preventers" on every main line, and each branch line throughout the distributing system. Thus if an explosion takes place on any part of the distributing system, it will be confined to a comparatively small section. Each of these "explosion preventers" consists of a joint of pipe filled with steel shavings and installed in the pressure line. For 6in. pipes, a joint of 12in. pipe is used. The principle involved is the same as used in a miner's safety lamp.

The Soviet authorities have recently issued figures relative to the output of platinum in Russia, which is almost exclusively confined to the Ural district. In 1913 the production was 157,453 troy ounces. During the war the output declined considerably. In 1917 it was 98,474 oz., in 1918 43,181 oz., in 1919 39,425 oz., and in 1920 11,323 oz. From 1922 production began to increase materially. In 1922 the figure was 22,500 oz., in 1923 30,000 oz., and in 1924 40,000 oz., and is growing at an increasing ratio. The method mainly used for obtaining platinum is "dredging." In 1923 the number of dredges working was twenty-three, but the number has now increased considerably, and is approaching the pre-war figure. Five dredges were obtained last year from America, and are probably in operation at the present time. Their work should be reflected in the outputs for 1926 and 1927.

About 50 per cent. of the world's production of antimony finds its way into the United States, and in times of peace 75 per cent. of the imports are utilised in the manufacture of type metal, anti-friction bearings for machinery, Britannia metal, and hard metal—antimonial lead—according to J. W. Furness, mining engineer, Bureau of Mines. Of the thirty odd uses to which antimony is put, virtually all can be replaced satisfactorily by substitutes, many of which are on a stronger industrial footing than antimony and its alloys; as an example, in the hardening of lead either calcium, barium, strontium, magnesium, or copper may be used. Alloys of barium and calcium successfully compete with antimonial alloys as bearing metals. Antimony is used as a pigment and as a mordant, but many metals can be used satisfactorily in its place. Antimony does not seem to possess any characteristics that make it irreplaceable. Broadly speaking, it is a cheap metal which can be used as a substitute for more expensive metals, and in many uses it replaces them and is not, as a rule, replaced by them.

Miscellanea.

The Government of the Federated Malay States has made a rule that dredgers for working tin deposits must contain at least 75 per cent. of British materials or they will not be given licence to operate.

Dover was temporarily thrown into darkness recently, the electric tramway service was stopped, and works with electrically driven machinery were brought to a standstill, owing to a breakdown at the Corporation's Electricity Works. Cables are at present being laid to connect the electricity stations of Dover and Folkestone for mutual supply, the Electricity Commissioners having refused to sanction additional machinery.

It is reported by the National Federation of Iron and Steel Manufacturers that at the end of October five furnaces remained in blast compared with 147 in blast on the eve of the coal stoppage. Production of pig iron amounted to 13,100 tons compared with 12,500 tons in September, 539,100 tons in April and 473,700 tons in October, 1925. Steel production amounted to 92,900 tons, compared with 95,700 tons in September, 661,000 tons in April, and 652,400 tons in October, 1925.

Now that dry coal from the old open cut at Yallourn, Australia, can be obtained in large quantities, it is being used in the briquetting factory, and also for many of the boilers in the power-house. In the boilers the dry coal from the old mine is being mixed with the wet coal from the new open cut, and the aggregate moisture content of the fuel is thus reduced. At present eight boilers are being fired with this fuel, the remaining two boilers being fitted with auxiliary step grates, which facilitate the burning of the wet coal from the new open cut.

The Italian Government has appointed a Commission, which has already started work, to study and report on the best form of construction for underground transport to relieve the surface traffic in Rome. The scheme calls for a number of lines, with a total length of 27 miles, radiating from a common centre to serve all sections of the city. The work, which is expected to take ten years, will be entrusted to local contractors only. It is hoped that the gradual completion of this underground railway will permit of the removal from the streets of the tramways.

Of all the agricultural industries of Quebec, very few are more interesting or more important than the manufacture of maple sugar and maple syrup. The province of Quebec enjoys almost a monopoly in that industry, as four-fifths of the total yield of the products of the maple in Canada are supplied by the province. The first statistics furnished for the whole of Canada go back to 1851. Between that date and 1861 the annual production was 13,500,000 lb. Recently the yield exceeded 31,000,000 lb. It is claimed that 20,000 persons are interested in the making of maple sugar in the province.

Just over two years ago an outcrop of massive lepidolite was discovered at Pointe du Bois, near Winnipeg, and within the last twelve months spodumene and montebrasite have also been identified. It is also believed that further prospecting will uncover other and similar deposits in South-Eastern Manitoba and in Western Ontario. An analysis of a hand-picked sample, judged to represent approximately the lithium-bearing rock after the gangue has been removed, gave 4·76 per cent. of lithia (Li_2O), and there is estimated, according to the *Chemical Trade Journal*, to be in this deposit alone reserves capable of supplying the world's needs for many years to come.

During the past few days a well-known mining company has carried out exploration work regarding certain lodes of tin-bearing ores at the Gwennap United Mines, which are situated in a part of Cornwall noted for the richness of its minerals. The operations, which were confined to what is known locally as the white-work section of the mine—so-called in consequence of the white nature of the rock, composed principally of decomposed granite—are stated to have proved successful. Much interest is centred in the present activity, and hopes have been raised that Gwennap will once again become the prosperous tin-mining centre it was a hundred years ago. Then it had thirty mines working and gave employment to 7000 people, whereas to-day it can boast only two mines and 550 employees.

The expenditure on the Hume reservoir works on the Murray River, Australia, to date has amounted to £1,666,000. The original capacity of the dam was to have been 1,100,000 acre feet, but as a result of recent discussions, designs for a reservoir of 2,000,000 acre feet have been approved, and work is proceeding on that basis. The estimated cost of a reservoir of 1,100,000 acre feet was £2,547,000, but with the addition of £40,700 for special outlet works suitable for hydro-electric generation and £350,000 as the approximate cost of the increase of the capacity to 2,000,000 acre feet, the estimate has now been brought to £2,937,700. It is estimated that the Hume reservoir for a capacity of 1,100,000 acre feet could be finished by 1930, and for a capacity of 2,000,000 acre feet by 1932. It will probably be possible to store 200,000 acre feet in 1928 and 400,000 acre feet in 1929.

The extension of electrical supplies and the expansion of beet sugar production figure prominently among the latest guarantees which the Treasury has given up to September 30th, under the Trade Facilities Acts. The electricity companies concerned and the amount of the guarantees are:—Teignmouth Electric Lighting Company, Ltd., £12,500; East Suffolk Electricity Distribution Company, Ltd., £20,000; Electricity Distribution of North Wales and District, Ltd., £50,000—in addition to a previous guarantee of £100,000; and North Wales Power Company, Ltd., £300,000—in addition to previous guarantees of £1,500,000 and £200,000. The Anglo-Scottish Beet Sugar Corporation, Ltd., is receiving an additional guarantee of £240,000; and the Orchard Sugar Company, Ltd., an additional guarantee of £100,000. Both these are for beet sugar production. The largest item in the list is £2,250,000 for the Gedaref Railway and Development Company, Sudan, for the purchase of material in this country for the development of the Sudan Government Railways. The Cairn Line of Steamships, Ltd., has withdrawn an application for £130,000. The net amount of the guarantees up to the end of September is £67,985,780.

NEW WATER SUPPLY WORKS FOR ABERDEEN

MR. GEORGE MITCHELL, M. Inst. C.E., ABERDEEN, ENGINEER

(*For description see page* 545)

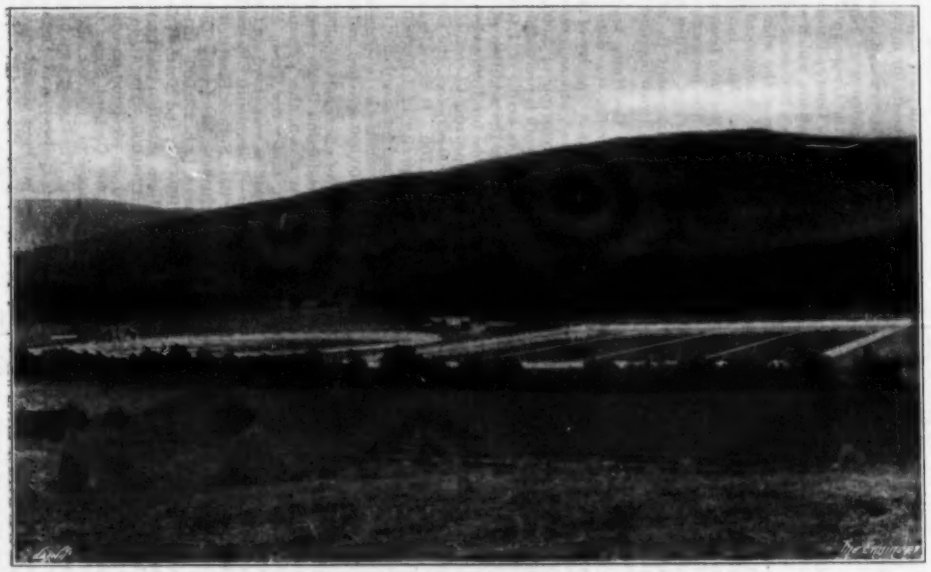

FIG. 8—GENERAL VIEW OF STORAGE RESERVOIRS AT INVERCANNIE

FIG. 9—NEW STORAGE RESERVOIR AT INVERCANNIE UNDER CONSTRUCTION

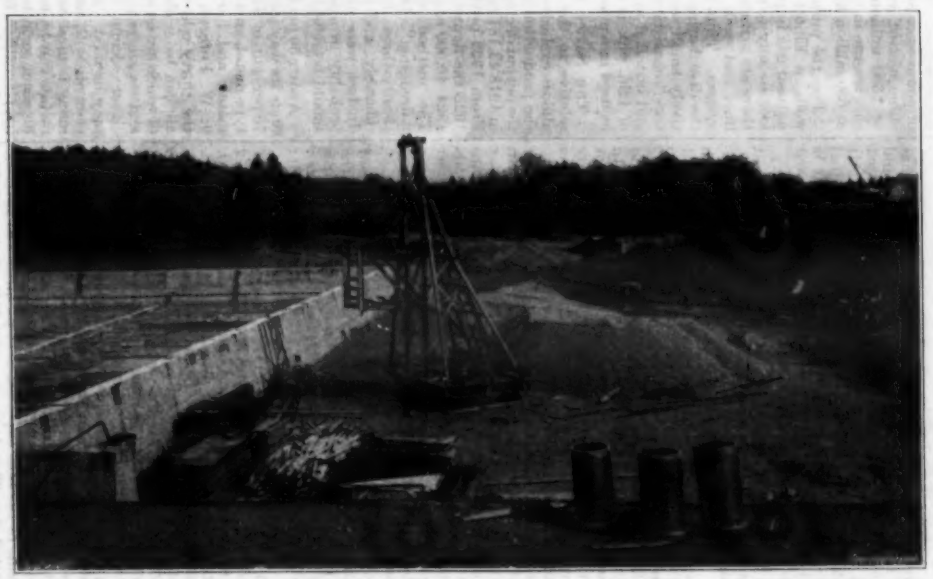

FIG. 10—FILTER BEDS AT INVERCANNIE UNDER CONSTRUCTION

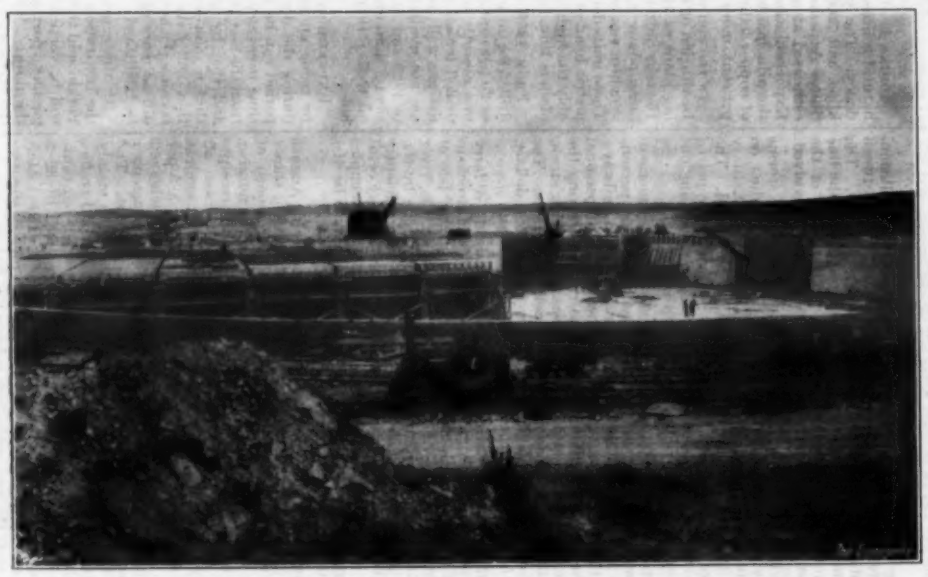

FIG. 11—SERVICE RESERVOIR AT AIRY HALL UNDER CONSTRUCTION

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THE ENGINEER.

NOVEMBER 19, 1926.

The Coal Dispute.

The spirit of toleration which characterises the British nation has never been exhibited with more disastrous results than during the past seven months. An exaggerated sense of fair play, combined with a reluctance to make a martyr—for fear of the consequences—has made it possible for a single man to check the revival of industry, to cause grave inconvenience to many millions of people, to increase the burden of taxation, and to cost the country a sum which has been estimated at five hundred million pounds. "A sight," indeed, "to make surrounding nations stare." We find it hard to believe that there is any other people under the sun who would have exhibited such patience. When negotiations had broken down in August, when it was evident that in most districts satisfactory terms had been arranged between the miners and the mine owners, when the men were already beginning to flock back to work and there was no sound evidence that a material majority of them desired to continue the struggle, it was carrying the principle of freedom of speech to the limit of folly to permit Mr. Cook to pursue his methods. There may be sound arguments on the miners' side, there may be serious faults upon the owners' side, but the interests of neither should have been allowed to weigh against the interest of the community as a whole, and the spirit of justice was extended beyond the bounds of reason, beyond the limits of common use—for in great issues strict justice must be, and always is, tempered by expediency—to permit one man to prolong a dispute of which the inevitable end was already in sight. When, moreover, as is commonly admitted, there was something deeper behind the industrial dispute the folly of that course is made doubly clear.

Looking back now, from the final mile-post, upon the course run by the whole deplorable affair we are impressed by one fact more than by any others. It is that the interference of Government in a specific dispute is a policy pregnant always with a monstrous issue. The mistake began when Mr. Baldwin gave the coal mining industry a subsidy of over half a million pounds per week. The intention was admirable. There was some evidence in August, 1925, that trade was about to enjoy an improvement, which a cessation of the coal supply would have arrested. With a confidence, which we now see was misplaced, the Government agreed to aid the industry, whilst a Royal Commission made a thorough investigation of coal-mining methods. The evil day was delayed. The industry carried on with a shadow hanging over it. The report of the Royal Commission appeared. It satisfied neither party. The owners, indeed, avowed their acceptance of it; the men, possibly with greater candour, rejected it. The hope that it would provide the basis for a settlement which would avoid the closing of the mines vanished within three days of its publication. It appeared on March 10th. On April 30th the subsidy ceased. Fortunately, Mr. Baldwin held firm by that date and refused absolutely to extend it by another day. But the harm had been done. The great strike—the most colossal folly of which trade unionism has ever been guilty—followed. It ended as it was bound to end, but the Government was now thoroughly embroiled. It sought to effect negotiations and continued to do so until October 8th. There is, to our minds, little doubt that these efforts prolonged the struggle. Till the last Mr. Cook, and those whom he led, believed that the Government would put pressure upon the owners and force them to accept conditions which were clearly uneconomical. But the owners had no intention of committing so grave a folly. They had secured what they knew was needed. The permissive Eight Hours Act had received the Royal Assent on July 8th. It opened the way to a reasonable issue from the affliction of the industry, and was the wisest step taken by the Government from beginning to end. From the passage of that measure we may date the beginning of the end. Had the Government there and then washed its hands of the whole affair, had it done no more than refuse to permit a useless and enormously costly struggle to be carried on, against the wishes of by far the greater number of the people, and, we may add, with the help of one million and a-quarter pounds of Russian gold, the dispute would have hastened to the end which it is now reaching, and industry might have resumed its way in August instead of in December. It may or may not end now with an agreement—an agreement drafted to enable Mr. Cook to capitulate with honours and for no other manifest reason.

At the end of the long struggle we shall be back at the fundamental issues upon which it began. No industry can be carried on indefinitely upon uneconomical methods. The miners refused to see that patent fact. It has, after seven months of fighting, been brought home to them. In many mines already they are, under the Eight Hours' Act, earning more money than before, and they are doing more to earn it. The mines will improve progressively in other respects. The Royal Commission report is dead. It was still-born for the purpose for which it was intended. But it revealed many facts about the coal-mining industry, it showed the directions in which renaissance is to be sought, and it will not be without its influence for good. With peace restored to the industry technical developments will take place, and many of the defects to which the Royal Commission referred will, step by step, be removed. The greatest good that we dare hope for from the conflict is that it will be followed by some years of harmony and progress. We have spoken of the harm done by Government interference in the dispute. We do not saddle this Government with the responsibility; it was forced upon it. For many years past there has been an increasing tendency to rely upon the Cabinet to interfere in trade disputes. That is a grave error. Governmental intrusion, even when it is not invoked for purely political purposes, tends to prolong, not to shorten, such disputes, and if the manifest harm that it has done in this case is taken to heart we may, perchance, add the rejection of that bad principle to the meagre benefits which the senseless conflict may bring in its train.

The Limitation of Navies.

In the absence of news to the contrary it is to be feared that the labours of the Preparatory Commission on Disarmament, which met at Geneva last May and has since held numerous sittings, have not yet led to positive results. Had it been otherwise the fact would certainly have been broadcast as a matter of international importance. From the somewhat meagre reports of the proceedings which have come to hand, it is evident that fundamental differences of opinion exist among the various Powers on the subject of armament limitation. The attempt to discover a formula for the reciprocal reduction of armies and air forces appears to have failed completely, hedged about as this question is with thorny political issues which have hitherto baffled every resource of statesmanship.

Nor does any greater measure of success seem to have attended the effort to devise ratios of strength in those elements of naval power which lie outside the scope of the Washington Treaty. France, for example, is unwilling to draw any distinction between her land and sea forces, holding them to be one and indivisible from the point of view of national defence. Italy and other continental states have adopted a similar attitude. America, on the other hand, virtually disclaims interest in the problem of land armaments, and, according to her delegates at Geneva, is only concerned to bring about a further reduction in naval strength. Great Britain and Japan are in sympathy with the American view, even if their respective geographical situations do not permit them to be quite so indifferent to questions of land power. But, since battleship fleets are already subject to restriction, the chief incentive to naval rivalry has disappeared, and we must confess our inability to comprehend American anxiety on this score. There appears to be an impression in the United States, carefully fostered by the Service interests of that country, that the Washington Treaty has done little or nothing to check competitive building abroad, and that in consequence, the American Navy is falling below the standard of power prescribed by the Treaty. A very active propaganda, not wholly free from a suspicion of official encouragement, is being conducted on these lines, the purpose being to induce Congress to make larger appropriations for new construction. No objection could be taken to this movement were it not for the tendency to misrepresent Great Britain as the protagonist in the new "naval race." It may therefore be opportune to review the facts.

A study of current programmes at home and abroad fails to reveal any signs of what could fairly be termed a naval competition. Since the year 1921 only two capital ships have been laid down anywhere in the world, and the idea that energy formerly spent on such vessels is now devoted to the production of other types of fighting craft is not borne out by statistics. British shipbuilding operations since the war have been on a decidedly modest scale. In spite of our dependence on the integrity of the sea routes and the pronounced shortage of cruisers for commerce protection, six years elapsed before we began to build vessels of this class, the first batch of five being laid down towards the end of 1924. In the meantime, however, the construction of more than thirty cruising ships for foreign navies had been begun. From the Washington Conference to the present date—that is, a period of five years—we have laid down twelve cruisers, two destroyers, and four submarines. If that is "setting the pace" in naval construction, words have lost their meaning. It is true that Parliament last year adopted a programme for the systematic replacement of obsolete cruisers and other light craft during the ensuing five years. This programme, however, is liable to be modified in the event of a change of administration, and in any case the aggregate of tonnage which it represents is considerably less than the total provided under the post-war building schemes of the United States, France or Japan. So far from having led the way in naval construction during the post-war era, we have lagged behind, and the amount of leeway to be made up, if we wish to preserve a measure of sea power at all proportionate to our needs, is very great. It would, no doubt, have been better for all concerned had the Washington Conference imposed a check on the multiplication of cruisers and submarines, as well as on heavier ships. That it failed to so do was emphatically not the fault of Great Britain. Had our proposal for the abolition of submarines been supported by the United States, it is scarcely to be doubted that the attempt to eliminate these craft would have succeeded, in which case the way would have been left clear for an all-round limitation of combatant shipping. But no such support was forthcoming. The United States joined with France in conferring a formal benediction on the submarine, thus rendering impracticable the restriction of the light surface craft which are its natural enemies. Recrimination is futile, as President Coolidge has just reminded the world, but in view of the persistence with which American publicists saddle this country with responsibility for a naval competition which they alone are able to discern, it is pertinent to recall the antecedent conditions from which the present situation has developed. So far as we are able to ascertain, the American naval authorities are disturbed by the growth of foreign cruising fleets, and are anxious to arrest it by a new treaty of limitation. But this, as we have seen, is impossible so long as submarines continue to form an integral component of the naval organism. The destroyer is needed primarily to combat the submarine, and the cruiser must be there to afford protection to the destroyer engaged in anti-submarine operations. The United States, virtually self-supporting in the matter of food supplies and other essential commodities, and separated from potential enemies by the width of oceans, are less in need of naval power than Great Britain. That is a self-evident fact, which no amount of propaganda can alter or obscure. Nevertheless, if the United States desire to expand their navy, and even to bring it up to the Washington Treaty standard in every class of tonnage, nobody in this country is likely to raise the slightest objection. It seems unreasonable, however, to expect us to reduce our fleet to a level inconsistent with our minimum needs merely in order that the United States may be spared the expense of building new ships. The truth is that Great Britain has already made very serious sacrifices in the cause of disarmament. For several years after the war we voluntarily observed a "naval holiday" while other Powers, including the United States, were turning out new ships in large numbers. When the pace became too hot and the Washington Conference was convoked, we accepted without demur an American proposal that deprived us of our traditional supremacy at sea, and left us with a battle fleet absurdly small in proportion to our naval commitments. Nor was that all. The building of warships had been for many years one of our great national industries. This industry was practically ruined by the Limitation Treaty, and the loss which the country has sustained thereby is incalculable. Yet in spite of its serious drawbacks, both from the naval and economic points of view, we have loyally adhered to the Treaty in letter and in spirit, accepting it with better grace than certain other countries to whom it is far more advantageous.

Whether any further restriction of naval armaments can be brought about depends, in the first instance, on the international attitude towards the submarine. At present this weapon is being actively developed abroad, and we notice that the United States, France and Japan are all constructing boats that surpass the British X 1, which has hitherto held the record for tonnage. More than seventy submarines are already under construction or projected for the foreign Governments which are associated with us in the Washington Treaty, and new programmes are in view. While this state of affairs continues, we cannot see any prospect of a reduction in the cruiser and destroyer establishments which jointly constitute the main defence against submarine aggression. At the same time, however, the sum total of naval shipbuilding now in hand is small compared with the average volume in any year prior to the Treaty, the rate of construction is very much slower, and there is no definite symptom of a competitive spirit in any quarter. Naval disarmament, in the literal sense, remains a vision which can hardly be realised till the Millennium; but a survey of the world's navies to-day shows that naval limitation is an accomplished fact. The discussions at Geneva will serve a useful purpose if they focus attention on the main obstacle to further progress in this direction, which we hold to be the continued existence of the submarine.

The Electricity Bill.

By Colonel R. E. CROMPTON.

The Electricity Bill passed the House of Commons on Friday last and is now before the House of Lords for further consideration.

In *The Times* of November 15th a strongly worded letter of protest against the Bill, signed by a number of leading men who are responsible for electric supply, puts forward very strong arguments to show that the Prime Minister's object in bringing in this Bill to secure to the general public an abundant and cheap electrical supply will not be so well attained by the Bill in its present form, as if it were simplified so as to confer certain well-defined additional powers upon the existing body of Electricity Commissioners.

When last spring the Prime Minister stated that he was about to introduce a Bill which would cheapen electric supply and put it in the power of the humblest to have all its advantages, we who had devoted our lives to developing electrical energy felt complimented and pleased.

The time is opportune to put before your readers the view of those who, like myself, have been responsible for the development of electrical engineering in this country. In the first place, the Bill dwells far too much on the advantages of using fewer large generating stations interconnected by what is called the grid, which will make great reductions in the generating cost. Now, although it is undoubtedly true that from the nature of things, both the private companies and local authorities who have established a large number of local generating stations of small size have been compelled to charge what appears to be a high price to the user, this high price is not chiefly due to high generating cost, but in most cases to the nature of the demand, which up to the present has been so largely for lighting. It follows that the overhead charges, which must be met, whether the scale of production is small or large, have to be divided over a comparatively small number of hours of user per annum; in other words, to what I in my paper read before the Institution of Civil Engineers in 1891, called a low load factor. It is this low load factor, common to all the smaller distributing centres, where supply is mainly for lighting, that entails a high price, in fact a price prohibitive to any but the wealthier classes.

Wherever in England and Scotland it has been found possible to reduce the total cost and hence the price to the consumer to a low figure, it will be found that this is in the districts where power is extensively used for industrial purposes, such as in the manufacturing districts of Lancashire and Yorkshire, Clydeside, Tyneside, and around Birmingham and other large manufacturing towns. In all these cases the output for power being large, the average price charged for lighting and power is already as low as in any country in the world where electrical energy is obtained from coal.

When the Bill was introduced we, the enthusiasts, believed that the Government would give aid to supplying the rural districts of England at a cheap rate. We thought that this would follow from the tapping of the grid wherever it passes through rural districts at points where it was desirable to foster the rural demand which we all think would be a most important factor in developing agriculture generally and improving the position of the agriculturist. However, there is no sign of this in the Bill as it now stands. The authority which is to be set up has no power to assist this rural development, however much it may desire to do so; it is only authorised to raise money for improving or enlarging existing generating centres and making them more efficient as such, and to add on to the cost of generation that of constructing and maintaining a vast system of interconnecting mains, about which none of us have sufficient information to enable us to say whether the overhead charges on these interconnecting mains will not increase rather than lower the selling price.

Again, in the Bill not a word is said about the incidence of local taxation; those who like myself have been engaged in the supply of London know how heavily this bears on our costs and hence on the price at which we can afford to sell to our customers. The works of most of the London companies are assessed in such a manner that the charge for rates worked out per unit sold is in many cases higher than the present coal bill, and in view of further improvements in generating costs this fixed charge will bear a still higher proportion to the coal bill.

It is difficult to overstate the extent to which the electrical industry has suffered from legislation in the past, from the time when in 1882 Joseph Chamberlain introduced his Bill which limited the tenure of electric supply undertakings to twenty-one years, right up to the present amending Bills, which have allowed the London supply companies to join forces for generating purposes; the same principle has been followed, i.e., that at the end of a fixed period the whole of the works are to be handed over to either a municipal or to a national authority. There has never been any reason why the electrical industry should have been handicapped by this short tenure as compared with its well-organised rival the great gas industry.

In conclusion, it is a great mistake to suppose that the electrical industry has already reached a point where it can be treated as if it were as well developed and understood as other public services, such as the supply of water or gas. We have now before us many directions in which electrical supply may be of immense use and comfort to the householder as well as to the manufacturer. Many of these developments depend on low price; prices must be lowered in order to obtain their use, so that increased user can be again followed by further reduction in price. Much remains to be done in the direction of utilising electric power for domestic purposes, for cooking apparatus, for local heating, and last, but by no means least, production of artificially cooled safes or larders in which food of a perishable nature can be stored in the home.

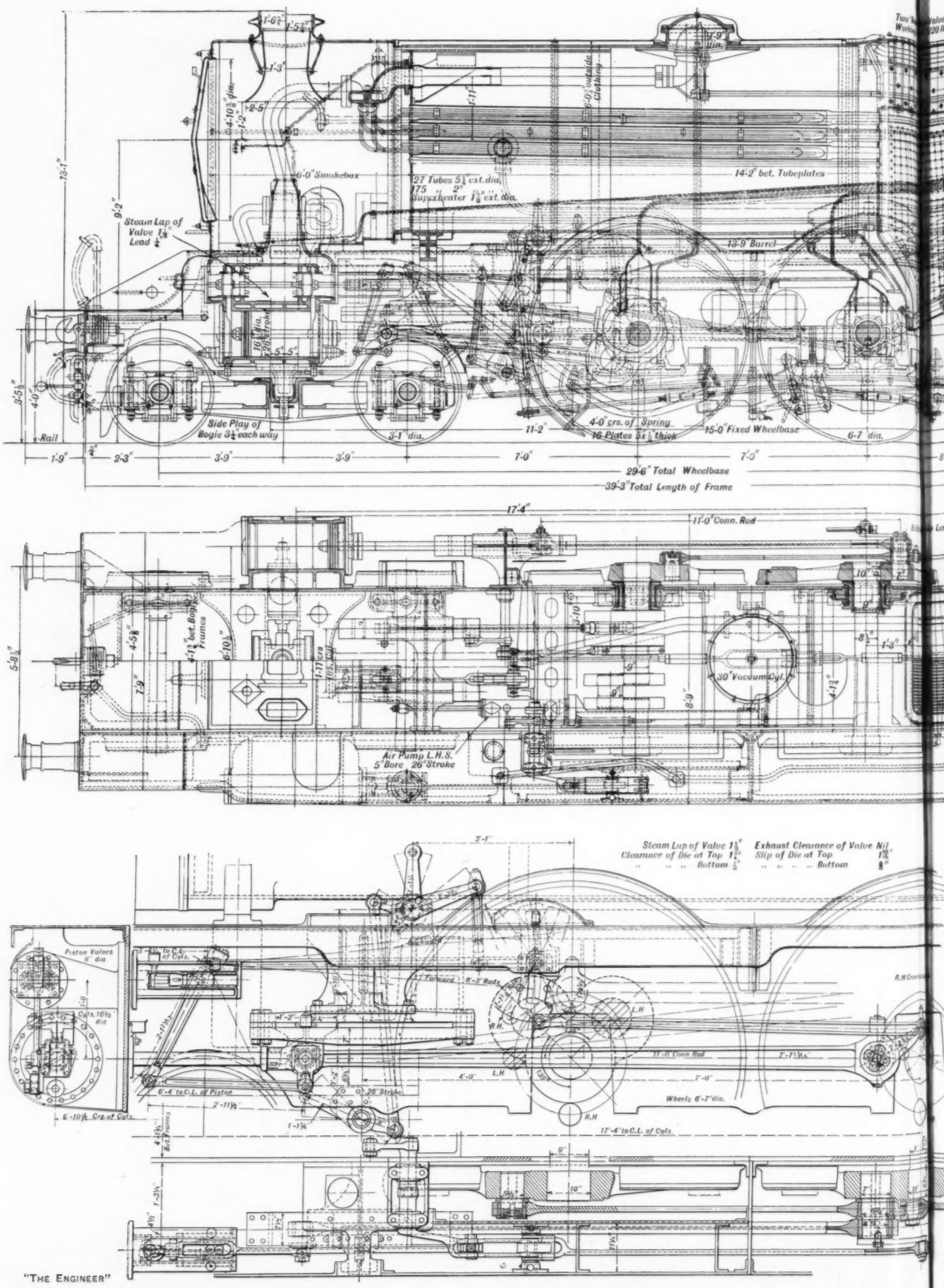
It is to be deplored that in the Bill as it now stands no power is given to the new authority to spend money on research in any of the above-mentioned matters or in the highly important one of improving the treatment of the soil by electrical cultivation, and by electrical means of obtaining nitrified products from the atmosphere. But even if further research shows that these uses of electrical energy on the farm are still in the experimental stage, Borlase Matthews and others have, I think, already proved their case that the total output from a farm can be materially increased by using electric light, heat and power.

Work has been started on the development of the Paugan Falls on the Gatineau River, Ontario. The plant is to be of 200,000 horse-power.

UNIV. OF MICH.

SOUTHERN RAILWAY—FOUR-CYLINDER, SIX-COUPLED

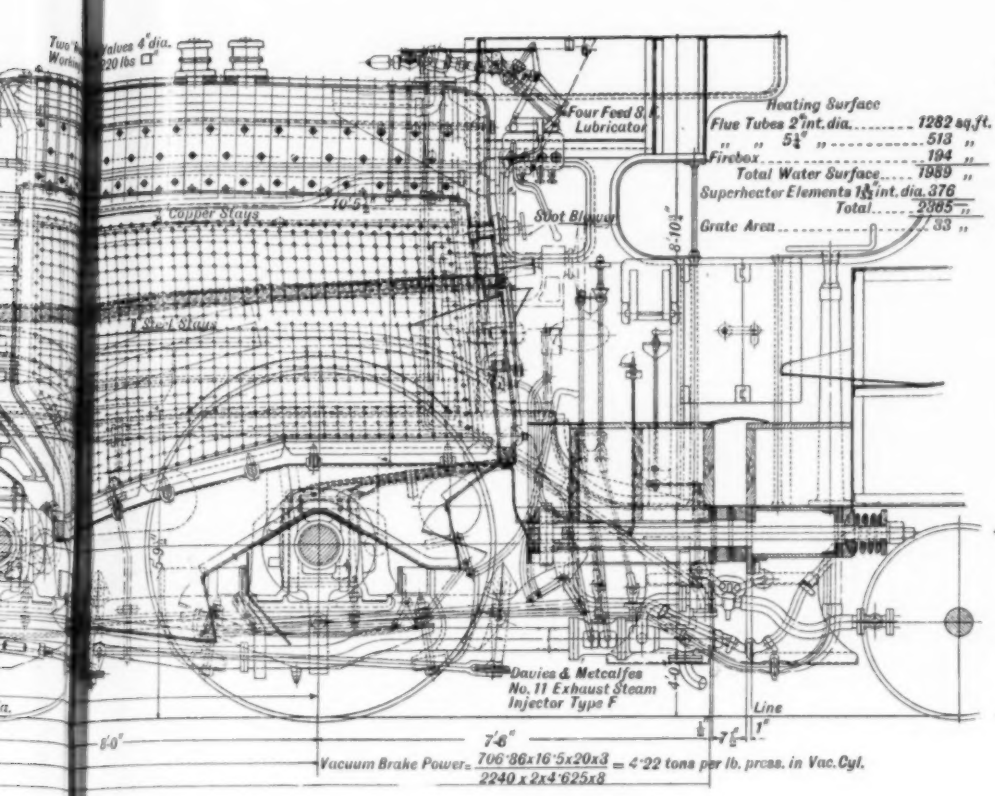
MR. R. E. L. MAUNSELL, M.I.



"THE ENGINEER"

X-COUPLED EXPRESS LOCOMOTIVE "LORD NELSON"

MAUNSELL, M. Mech. E., ENGINEER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" " 5¼" " 513 "
Firebox 194 "
Total Water Surface 1989 "
Superheater Elements 1⅜" int. dia. 376
Total 2365 "
Grate Area 33 "
Four Feed & L. Lubricator
Copper Stays
Steel Stays
Soot Blower
Davies & Metcalfes No. 11 Exhaust Steam Injector Type F
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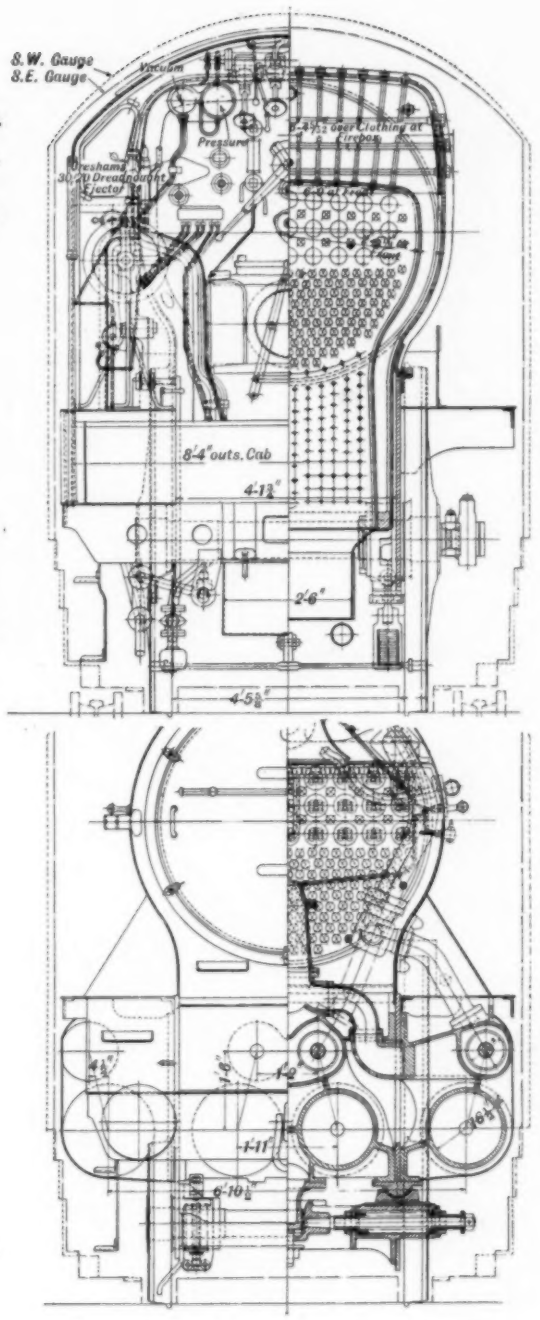
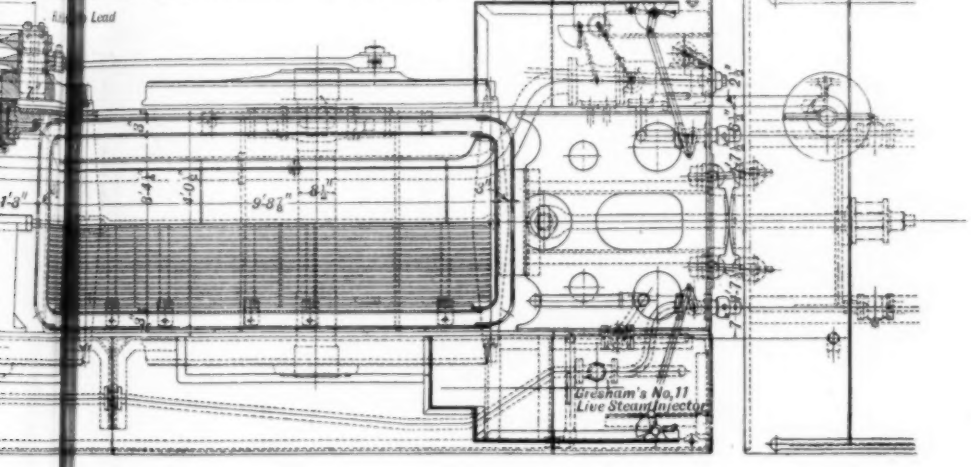
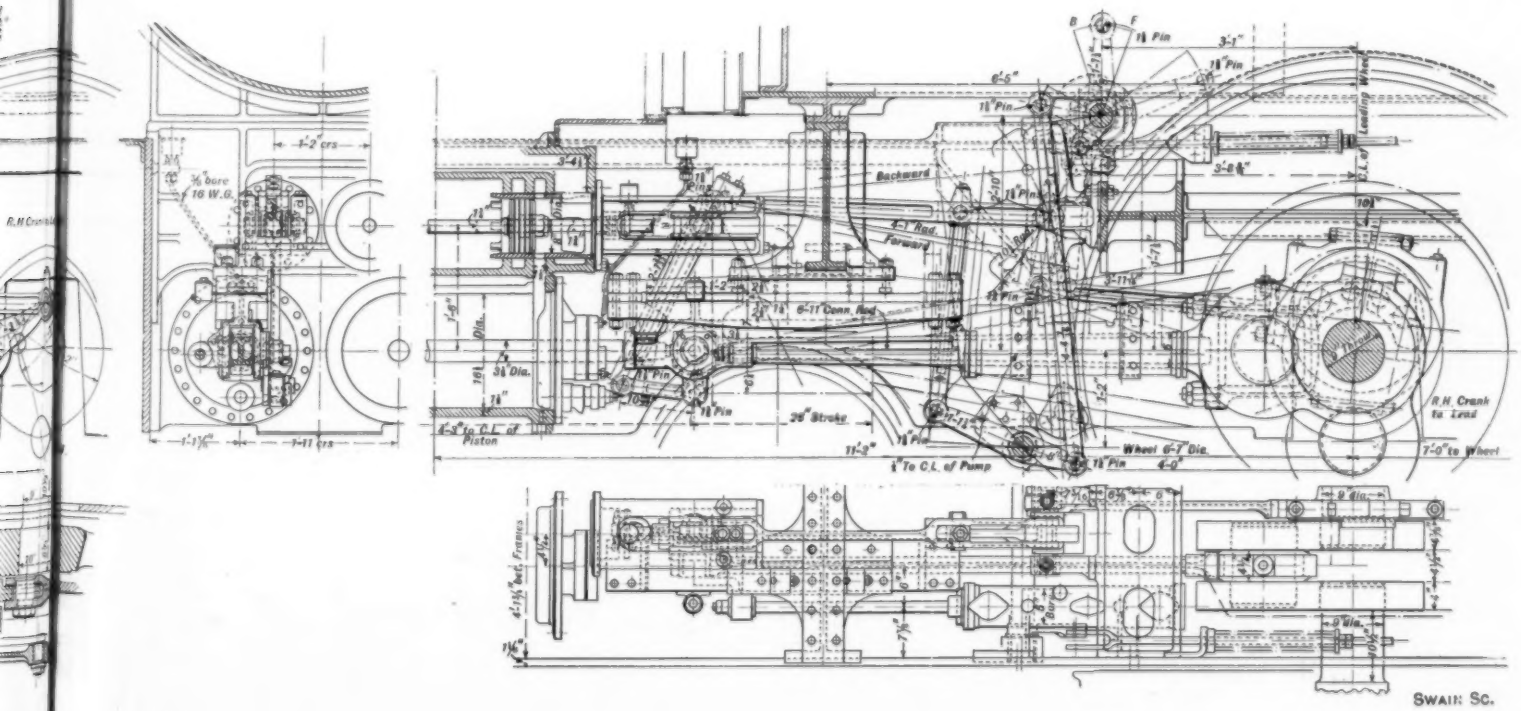






SWAIN Sc.

UNIV. OF MICH.

Literature.

The Venturesome Voyages of Captain Voss. New edition, with an introduction by WESTON MARTYR. London: Martin Hopkinson and Co., Ltd. 12s. 6d. net.

"A SMALL vessel is as safe at sea as a large one." These words, coming from the pen of an enthusiast, might be regarded by the sceptical as merely the fruit of his zeal. But when in a small yacht you have weathered a typhoon capable of sinking a 3000-ton steamer, you may surely claim to speak with some authority on the way of a little ship in the midst of the sea. Captain Voss is as good as his word and adds to the quality of master seaman the ability to relate his experiences with delightful simplicity.

It is fittingly romantic that the quest of hidden treasure should first have drawn Captain Voss into an adventure that even he regarded as dangerous in the extreme—a voyage from Victoria, British Columbia, to Cocos in a 10-ton sloop. The treasure, like all hidden treasure, turned out to be either non-existent or else hidden with a thoroughness that defied the keenest perception. As a financial proposition, therefore, the expedition WAS a failure. But in demonstrating the possibilities of a small vessel in the hands of a capable master it was an unqualified success. And a few years later we find the gallant seaman ready and willing to embark upon what is undoubtedly the most amazing adventure the sea has ever witnessed—the crossing of the three oceans in an Indian dugout canoe. This little vessel, Tilikum, 30ft. in length and with a beam of 5ft. 6in., decked and rigged for the purpose, covered the 40,000 miles between Victoria, B.C., and London by way of Australasia, South Africa, Brazil, and the Azores.

In the course of Tilikum's wonderful voyage some twenty major gales were successfully weathered; and later, 200 miles to the eastward of Yokohama, in the 25ft. yawl Sea Queen, Captain Voss and two companions fought a typhoon of exceptional violence—and won!

It may well be asked how these extraordinary feats were accomplished. And in the answering of this question lies the real value of the book. The author's knowledge of breaking seas — thanks to years spent in the closest acquaintance with them—of their speed, size, strength, habits and effect on shipping, is probably unequalled. And his methods of combating them deserve the attention not only of adventurous followers in his footsteps, but of the commanders of every kind of vessel up to the Atlantic greyhound.

Captain Voss estimated the speed of waves in the open ocean during various gales when they had attained full growth. "When hove to under a sea anchor," he says, "with a hundred and fifty feet of anchor rope out and when just on the top of a large wave, the sea anchor float which was fastened with fifteen feet of line would appear at a distance of a little less than halfway to the top of the next wave. By allowing for the angle in which the anchor rope inclined I ascertained an approximate total distance from crest to crest of three hundred feet. Under the same conditions I have measured the speed of the waves by marking the difference in time between two succeeding seas when their crests passed the boat. The interval was seven seconds on the average. In basing the calculation on the above figures an average speed of twenty-five and one-third nautical miles per hour is obtained."

The height of waves he discovered on large vessels from a position in the rigging at such a height that the tops of the large waves would appear a little below a line between his eyes and the horizon. The distance from the water line of the ship to the level of his eyes was known to him. In this way during a heavy gale in the South Pacific he found the height of the waves from trough to crest to amount to nearly 40ft.

The appalling destructiveness of a breaking sea is well known to every seaman, and such a sea will sweep over a tall ship in much the same way as it might sweep over a rock. Captain Voss explains that this is due to the fact that a ship under way is held down by suction, and that it is consequently advisable to heave to before any damage is done. Once way is stopped the ship will ride dry and comfortable. Even the tiny Tilikum, hove to under sea anchor and riding sail, would mount every sea with ease and without sustaining the slightest harm.

An excellent example is the case of the ss. Volmer, lost with fifteen members of her crew twenty-five miles south of the Scilly Isles. All night long the vessel was kept going full speed ahead in the teeth of a storm in order to keep steerage way, until finally a tremendous sea broke aboard, and besides sweeping away everything on deck, smashed in the hatchway and put out the fires, leaving the ship practically sinking. Then, despite her condition, the vessel swung round and, entirely out of control, kept afloat for five hours more in a heavy gale.

"Venturesome Voyages" was originally published in Yokohama in 1913, but the edition was almost entirely destroyed in the earthquake, with the result that the book, which deserves a high position, is up to the present practically unknown. It is only to be hoped that the present edition—an exact reprint—will attain that position and meet with better fortune than its predecessor.

Of Captain Voss, Mr. Weston Martyr writes:—"He built another tiny boat, and, in her, sailed away from us, out into the silent sea. And since that day I have neither seen nor heard of him again." But whether he sails the seas of this world or the next, he will appreciate the echo of his own "Good luck and a fair wind."

Kran-und Transportanlagen für Hütten, Hafen, Werft- und Werkstatt-Betriebe. Second edition. By C. MICHENFELDER. Berlin: Julius Springer. Price 67·50 Mk.

THE ultimate object of all handling operations, says Herr Michenfelder, is a means to an end in an industrial process. This is accentuated in handling processes in the iron and steel industry, where raw material, metal—solid or liquid—has to be rationally moved from process to process, and where manhandling is in most instances out of the question on account of the quantity and nature of the material to be dealt with. The author defines "rational handling" as a process which performs conveying in a technically and economically correct manner with a minimum expenditure of energy. Another important feature of mechanical handling in the iron and steel industry is the desirability when handling hot ingots, &c., of doing so along the shortest path and with the minimum of delay in order to prevent heat losses. Herr Michenfelder therefore enters into the question of the route-ing of material through the different departments or processes.

The development of the handling industry during the last fifteen years, i.e., since 1911—the date of the first edition of this work—has necessitated a considerable enlargement of the volume in order to bring it up to date. The classification employed is not, as is generally the case, according to handling methods and systems, but according to industry and purpose. For instance, the handling in metallurgical works is arranged in consecutive order of proceedings, beginning with the stockyard for raw materials, continuing from process to process, and finally concluding with the handling of the finished products in the stockyard. By the adoption of this method of classification an extensive index is not necessary. For a book of ready reference this method must be appreciated, even though it involves overlapping to some extent, since similar devices are often employed in different processes.

New sections in the present edition are those on Interdepartmental Vehicular Traffic by Accumulator Battery Trucks; Applications of Progressive Assembly; Cable Cranes and Chain and Bucket Dredgers.

This monumental publication is more particularly intended, as its sub-title implies, for the use of:—

I. Metallurgical engineers, especially those in the iron and steel industry;

II. Shipyard engineers; and

III. Dock and harbour authorities, and also those handling engineers who cater for these industries.

A review of so extensive a work must obviously be of a somewhat sketchy nature, on account of space limitation. The following summary of the scope of the book may therefore best serve as a guide; it will likewise show that many of the subjects treated have never been included in any previous text-book on this particular branch of engineering.

The first main section deals with:—

HANDLING DEVICES IN METALLURGICAL PLANTS,

and is subdivided under the following heads:—

A—Open-air Storage Yards for Raw Products, with unloading methods for rail and water-borne materials.
B—Charging Devices for Blast-furnaces, including ropeways, platform lifts, inclined hoists and cranes, telphers, &c.
C—Handling Devices for Purposes of Pig-bed Unloading, including manual unloading, semi-mechanical clearing, overhead runways, magnet cranes and pig-bed cranes.
D—Slag Conveyors.
E—Handling Devices in connection with Settling Basins and Tanks.
F—Feeding of Blast-furnaces by means of Vertical Platform Hoists, inclined or skip hoists, and overhead ropeways and cranes.
G—All Mechanical Devices in Connection with Scrap Iron Yards, including also hand loading, magnetic loaders; bundling; handling troughs or charging-boxes.
H—Plant Used in Connection with the Producer House.
I—Open-hearth Plant, and processes in connection therewith; hand charging; semi-mechanical charging, and charging cranes and trucks.
K—Open-hearth Casting Plant, including travelling ladles and casting cranes.
L—Plant for use in the Mixer House.
M—Plant for use in the Converter House.
N—Plant Used in Connection with Slag Handling.
O—Basic Steel Plant, including travelling ladles, strippers and stripper cranes.
P—Plant used in Connection with Soaking Pits, including devices for raising the lids of such pits, also lowering cranes for use in soaking pits.
R—Devices in Connection with Pressing and Forging Shops.
S—Ingot Store and Plant in Connection therewith, including tongs and magnet cranes.
T—Rolling Mills.
U—Stock and Loading Yards for Finished Products, including cranes for handling rails and joists, magnetic loaders, cranes for handling bars, and also plate cranes.
V—Handling and Construction Shops.
W—Deals with the various Foundries, including those for pipes and malleable iron.
X—Pickling Shops.

The second main heading deals with:—

SHIPYARD APPLIANCES.

A—Slipway Equipment, including stationary and travelling ground cranes, jib cranes on lateral high-level tracks, travelling cranes on slipway frames, ropeways, slipway hoists, and floating dock cranes.
B—Shipyard Equipment, including stationary and travelling tower cranes, floating cranes, and also salvage cranes for raising submarines.
C—Handling Stockyards.
D—Handling in Workshops.

The third main heading deals with:—

HARBOUR APPLIANCES.

A—Transhipment to Sheds or Wagons, including cranes, and data concerning dimensions and arrangement of driving gear. Semi-portal travelling cranes; portal, roof, and velocipede cranes; also stationary wharf cranes and electric overhead runways; electric accumulator trucks and minor conveying appliances; also Duplex cranes.
B—Methods of Transfer from Ship to Extensive Yards, including loading bridges and combination conveyor plants, and also cranes for heavy loads.
C—Transhipment from One Vessel to Another, including stationary transhipment cranes, floating transhipment cranes, and coaling appliances.
D—Methods of Transferring Material from Wagons to Shipboard, including shoots, wagon tipplers, steam navvies, excavating cranes, and cable dredgers.

The concluding chapter of the book deals with electricity as applied to crane practice.

Most of the installations described and illustrated are of German origin, but numerous typical examples of British, American, Dutch, and Italian plant are also fully dealt with, which renders the book a comprehensive treatise on its subjects.

In the iron and steel industry very numerous examples of handling machinery are employed, which cannot be designated as conveyors, but which are, nevertheless, as indispensable in conjunction with conveying appliances, as the grab is in connection with the crane. All such accessories which handle heavy and often incandescent masses of iron and steel in the manufacturing processes are exhaustively dealt with.

The book is written with an unbiassed mind, the criticisms are just, and it should therefore prove a useful guide to engineers in charge of such works as come within the scope of the publication. To judge from his work, the author is not only an experienced handling engineer, but has extensive knowledge regarding the lay-out and management of the class of work which is covered in his book.

The line illustrations are excellent, but the photographs and half-tone illustrations would, in some instances, have been clearer if better paper had been used.

Since, probably, none but crane builders would be as much interested in handling operations in iron and steel works as in shipbuilding and harbour work, it would have been better if this somewhat bulky publication had been issued in two volumes, purchasable separately, the first on handling in the iron and steel industry; and the second on handling in shipyards and harbours. Such treatment would have divided the book into two approximately equal parts, each containing slightly over 300 pages.

BOOKS RECEIVED.

Capitalism v. Socialism. By J. Taylor Peddie. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 7s. 6d. net.

The Hydrous Oxides. By H. Boyer Weiser. London: McGraw-Hill Publishing Company, Ltd., 6, Bouverie-street, E.C. 4. Price 25s. net.

Ventilation of Mines. By W. S. Weeks. London: The McGraw-Hill Publishing Company, Ltd., 6, Bouverie-street, E.C. 4. Price 15s. net.

The Chemistry of Cellulose and Wood. By A. W. Schorger. London: McGraw-Hill Publishing Company, Ltd., 6, Bouverie-street, E.C. 4. Price 30s.

The Largest Ships of the World. By V. S. Fellowes Wilson. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 10s. 6d. net.

Beiträge zur Geschichte der Technik und Industrie. Vol. 16. Edited by Conrad Matschoss. Berlin: V.D.I. Verlag G.m.b.H., Beuthstrasse 7, S.W. 19. Price 16 Mk.

Trade Unions and Trade Unionism. By Sir G. B. Hunter and E. T. Good. London: Hutchinson and Co. (Publishers), Ltd., Paternoster-row, E.C. 4. Price 6d. net.

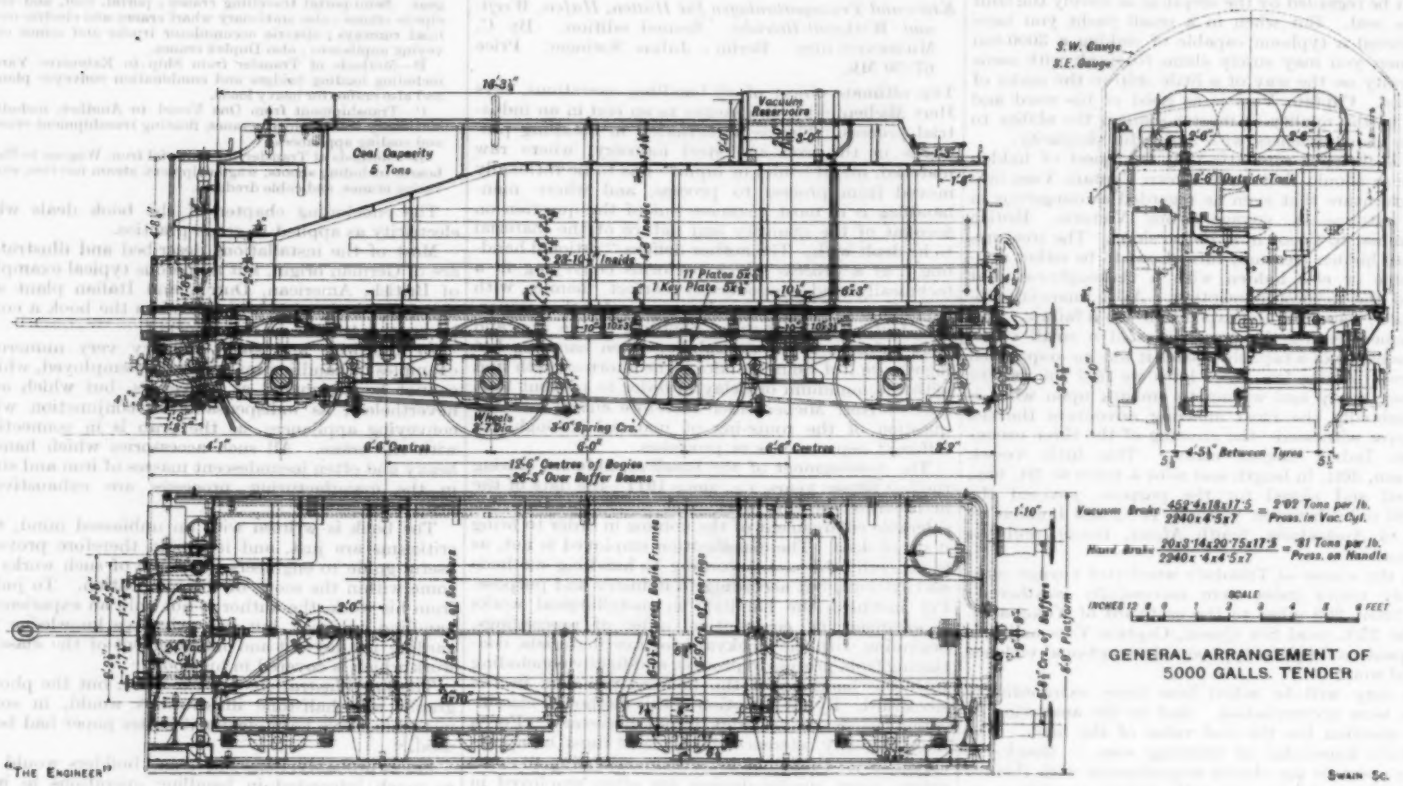
Transactions of the Institution of Naval Architects. Vol. LXVIII. Edited by R. W. Dana. London: The Institution of Naval Architects, 5, Adelphi-terrace, W.C. 2.

BIRMINGHAM ENGINEERS' WATERWORKS TOUR.—About 100 members of the Birmingham Association of the Institution of Civil Engineers on Saturday last paid a visit to the Sandfields Pumping Station, Lichfield, and the Shavers End Reservoir, Dudley. The invitation was extended to them by Mr. F. J. Dixon, the engineer-in-chief of the South Staffordshire Waterworks Company, who is a great believer in the value of young engineers visiting works in course of construction. Much interest was evinced in the Sandfields filtration plant, which is of the rapid gravity type, and is housed in a reinforced concrete building finished to imitate Caen stone, with panels in rough cast, and which is a striking landmark on the Birmingham road into Lichfield. The pumping plant in the old station adjoining has been remodelled, and each unit will pump three million gallons of water per day from the Lichfield wells and Hanch impounding reservoir to the Walsall service reservoir. It is worthy of note that the engines replace two sets of historic interest, in that they were originally made by James Watt as blowing engines for the old South Devon Railway. Special features in the design of the Shavers End Reservoir, which is constructed of reinforced concrete, and will hold seven million gallons of water, were explained to the engineers by Mr. Dixon,

SOUTHERN RAILWAY LOCOMOTIVE "LORD NELSON"—TENDER AND BOILER

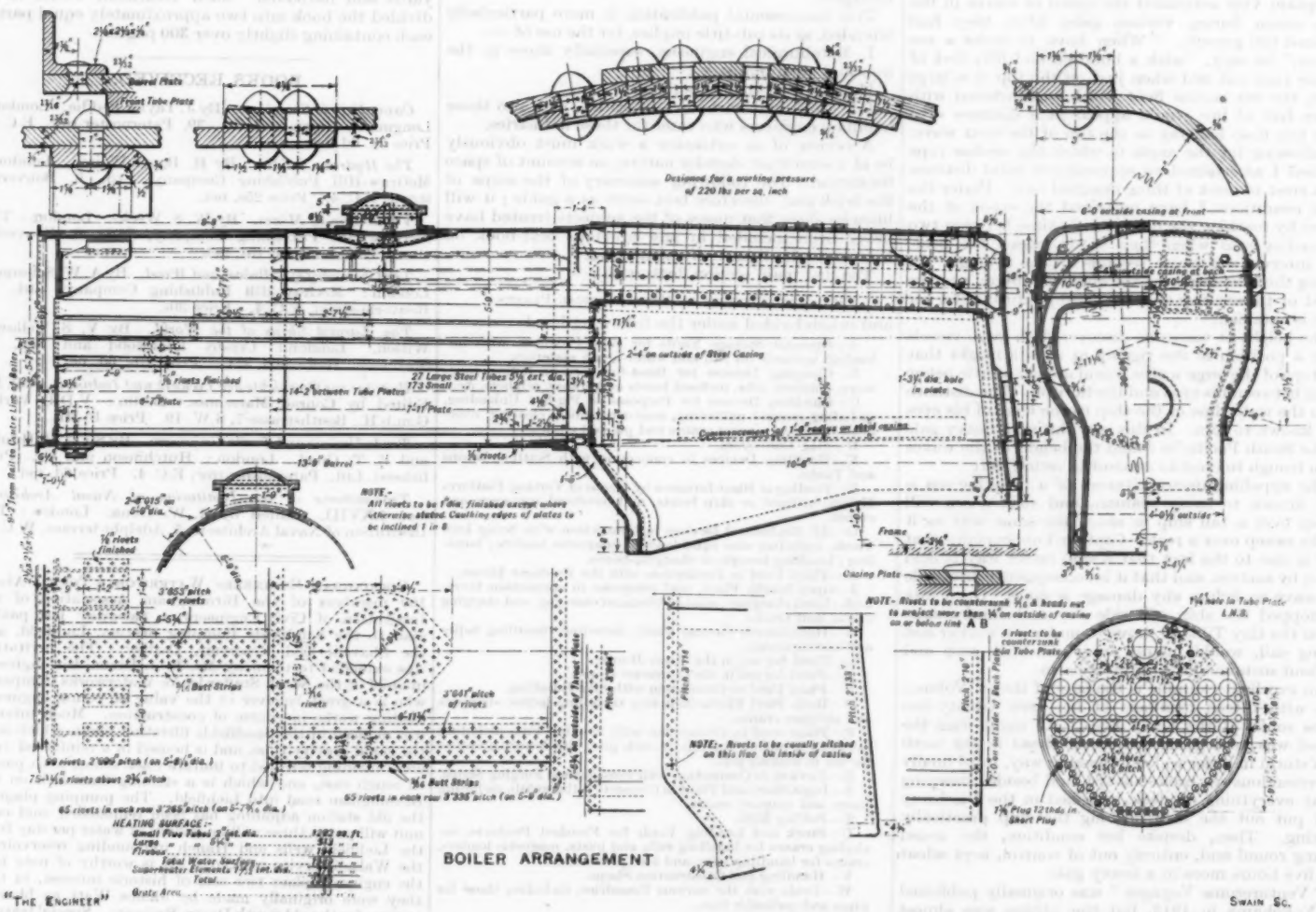
MR. R. E. L. MAUNSELL, M.I. Mech. E., ENGINEER

(For description see opposite page)


Coal Capacity 5 Tons
Vacuum Reservoir
S.W. Gauge
S.E. Gauge
6'-6" Outside Tank
28-10⅝" Inside
11 Plates 5⅛"
1 Key Plate 5⅛"
Wheels 6'-7" Dia.
3'-0" Spring Crs.
4'-5½" Between Tyres
4'-1"
6'-6" Centres
6'-0"
5'-2"
12'-6" Centres of Bogies
26'-5" Over Buffer Beams
Vacuum Brake 452·4x18x17·5 / 2240x4·5x7 = 2·02 Tons per lb. Press. in Vac. Cyl.
Hand Brake 20x3·14x20·75x17·5 / 2240x 4x4·5x7 = ·81 Tons per lb. Press. on Handle
SCALE
INCHES 12 6 0 1 2 3 4 5 6 FEET

GENERAL ARRANGEMENT OF 5000 GALLS. TENDER

"The Engineer" Swain Sc.


Designed for a working pressure of 220 lbs per sq. inch
27 Large Steel Tubes 5⅛" ext. dia.
173 Small " "
13'-9" Barrel
2-4" on outside of Steel Casing
1-3½" dia. hole in plate
Commencement of 1'-6" radius on steel casing
Frame
Casing Plate
6'-0" outside casing at front
6'-0" outside casing at back
NOTE.- All rivets to be 1" dia. finished except where otherwise stated. Caulking edges of plates to be inclined 1 in 8
NOTE- Rivets to be countersunk ⅛" & heads cut to project more than ¼" on outside of casing on or below line A B
NOTE:- Rivets to be usually pitched on this line On inside of casing
99 rivets 2·000" pitch (on 5'-8½" dia.)
75-1⅛" rivets about 2¾" pitch
65 rivets in each row 3·265" pitch (on 5'-7½" dia.)
65 rivets in each row 3·335" pitch (on 5'-8" dia.)
HEATING SURFACE :-
Small Flue Tubes 2" ext. dia. 1282 sq. ft.
Large " 5⅛" " " 313 " "
Firebox 194 " "
Total Water Surface
Superheater Elements 1⅜" int. dia. 178 " "
Total
Grate Area

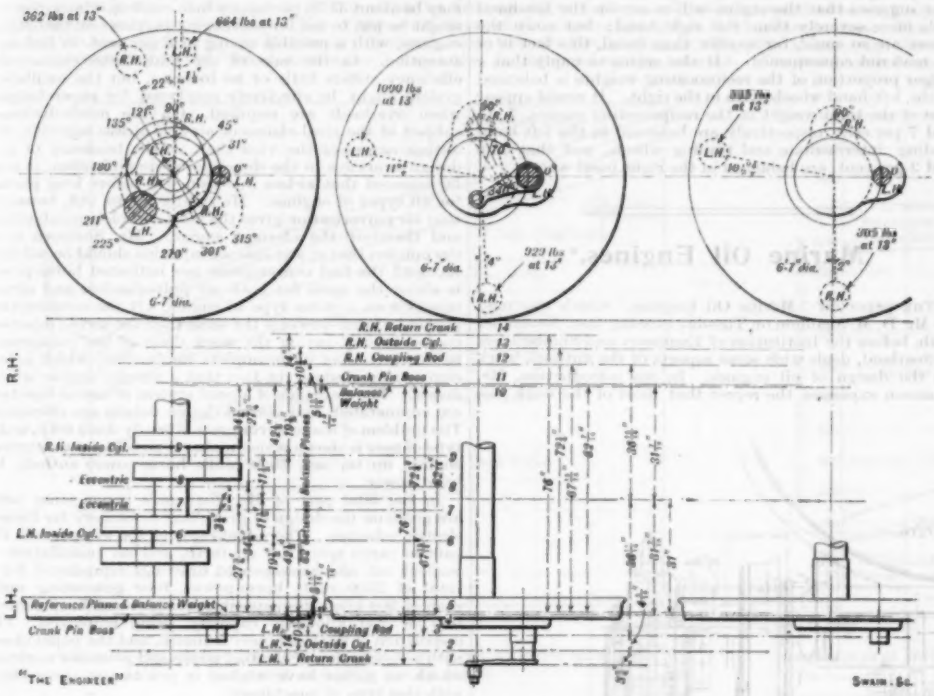
BOILER ARRANGEMENT

"The Engineer" Swain Sc.

Southern Railway—Four-cylinder Express Locomotive.

THROUGH the courtesy of Mr. R. E. L. Maunsell, we are able to give to-day a remarkable set of drawings of his new four-cylinder simple locomotive Lord Nelson. Some of these drawings are reproduced in a Supplement and some on this and other pages.

The general particulars of the engine were given in our issue of October 15th, when, in a leading article, we discussed some of the points of particular interest presented by the crank arrangement adopted. For convenience of reference, it seems probable that this order of cranks will be known as the "135° arrangement," owing to the fact that whilst the crank pins on each of the two driving axles are at 90 deg., one pair is set 135 deg. in advance of the other pair. This arrangement gives eight exhausts equally spaced in one revolution, and the equality and steadiness of blast thus secured has a marked effect upon the steaming power of the boiler. As a matter of fact, the boiler steams so freely that the blast nozzle has been enlarged in three successive steps. It is for this reason, no doubt, that Mr. Maunsell has found a grate area of 33 square feet ample. In this connection, the boiler drawing which appears upon page 558 is worthy of study. In Mr. Gresley's design, the fire-box falls behind the last pair of coupled wheels, and there is room to make it very wide and relatively short. Mr. Maunsell keeps his box between the wheels, thereby dispensing with the pair of small trailing wheels, but in order to get area he has had to make the grate 9ft. 9in. long. The forward extension of the tube plate will not escape attention. One has only to look at the general arrangement which is given in our Supplement to obtain a good idea of the fine proportions of the box.

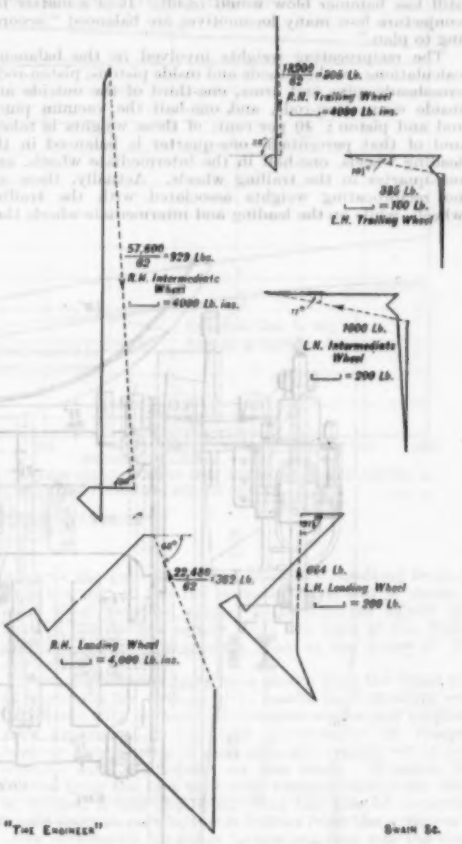


BALANCING DIAGRAMS

As a matter of convenience, we reproduce from our issue of October 15th a table of the leading dimensions :—

Boiler barrel—	
Outside diameter at fire-box	5ft. 9in.
Length	13ft. 9in.
Length between tube plates	14ft. 2in.
Fire-box shell—	
Width	4ft. 0½in.
Length	10ft. 6in.
Heating surface—	
Fire-box	194 sq. ft.
Small tubes	1282 sq. ft.
Large tubes	513 sq. ft.
Total	1989 sq. ft.
Superheater surface	376 sq. ft.
Grate area	33 sq. ft.
Cylinders (four),	16½in. dia. by 26in. stroke
Coupled wheels	6ft. 7in. dia.
Bogie wheels	3ft. 1in. dia.
Tractive effort at 85 per cent. boiler pressure	14·95 tons
Weight of engine in working order	83 tons 10 cwt.
Weight of tender in working order	56 tons 14 cwt.
Total weight	140 tons 4 cwt.

It is so rarely that inside Walschaerts gear is fitted that we are glad to be able to give in the bottom right-hand corner of our Supplement Mr. Maunsell's arrangement, and here we make note that the valves are of the "long stroke," or more properly the "long lap" type, the lap being 1¼in.



BALANCING POLYGONS

The drawings are so full of particulars that it would be redundant to deal further with them, but there are two other matters of the first importance about which a few words should be said. The first is the crank effort. This was got out for locomotives with this crank arrangement by Mr. Holcroft, and given in a paper which he read before the Institution of Locomotive Engineers in January,

BALANCE WEIGHT CALCULATIONS FOR FOUR-CYLINDER ENGINE.

Parts to be balanced.	Reciprocating weights.	Revolving weights at 13in. radius. Leading.	Intermediate.	Trailing.
		lb.	lb.	lb.
Return crank	—	—	27	—
½ of outside connecting-rod and included crank pin	—	—	251	—
Coupling rod (complete)	—	127	347	150
Crank pin boss	—	111	166	111
½ of inside connecting-rod and included crank pin	—	290	—	—
Crank webs	—	600	—	—
Excentric pulley and strap	—	130	—	—
Outside piston, rod, crosshead, pin and arm	459	57	113	57
½ of outside connecting-rod	108 } 40 per cent. = 227 lb.			
Inside piston, rod, crosshead, pin and arm	429	53	107	53
½ (vacuum pump rod and piston)	104 } 40 per cent. = 213 lb.			
½ inside connecting-rod				

Leading Wheels.

Plane.		Distance from reference plane.	Equival't mass at crank radius.	Equival't mass moment.
		inches.	lb.	
	L.H.:			
2	Outside cylinder reciprocating weights	10½	57	585
3	Coupling rod	5 11/16	127	754
4	Crank pin boss	7/16	111	49
5	Balance weight	—	664	—
6	Inside connecting-rod and pin	19½	290	5,660
6	Crank webs	19½	600	11,700
6	Inside cylinder reciprocating weights	19½	53	1,033
7	Excentric pulley and strap	27½	130	3,605
	R.H.:			
8	Excentric pulley and strap	34½	130	4,450
9	Inside cylinder reciprocating weights	42½	53	2,255
9	Crank webs	42½	600	25,500
9	Inside connecting-rod and pin	42½	290	12,340
10	Balance weight	62	362	22,480
11	Crank pin boss	62 7/16	111	6,930
12	Coupling rod	67 11/16	127	8,620
13	Outside cylinder reciprocating weights	72½	57	4,120

Intermediate Wheels.

Plane.		Distance from reference plane.	Equival't mass at crank radius.	Equival't mass moment.
		inches.	lb.	
	L.H.:			
1	Return crank	14	27	378
2	Outside cylinder reciprocating weights	10½	113	1,160
2	Outside connecting-rod and pin	10½	251	2,370
3	Coupling rod	5 11/16	347	2,080
4	Crank pin boss	7/16	166	73
5	Balance weight	—	1,000	—
6	Inside cylinder reciprocating weights	19½	107	2,085
	R.H.:			
9	Inside cylinder reciprocating weights	42½	107	4,550
10	Balance weight	62	929	57,600
11	Crank pin boss	62 7/16	166	10,370
12	Coupling rod	67 11/16	347	23,590
13	Outside connecting-rod and pin	72½	251	18,120
13	Outside cylinder reciprocating weights	72½	113	8,160
14	Return crank	76	27	2,050

Trailing Wheels.

Plane.		Distance from reference plane.	Equival't mass at crank radius.	Equival't mass moment.
		inches.	lb.	
	L.H.:			
2	Outside cylinder reciprocating weights	10½	57	585
3	Coupling rod	5 11/16	150	890
4	Crank pin boss	7/16	111	49
5	Balance weight	—	335	—
6	Inside cylinder reciprocating weights	19½	53	1,033
	R.H.:			
9	Inside cylinder reciprocating weights	42½	53	2,255
10	Balance weight	62	305	18,900
11	Crank pin boss	62 7/16	111	6,930
12	Coupling rod	67 11/16	150	10,180
13	Outside cylinder reciprocating weights	72½	57	4,120

Hammer blow at 60 m.p.h.

Left leading wheel	0·75 ton
Right leading	0·31 ton
Left intermediate	1·51 ton
Right intermediate	0·61 ton
Left trailing	0·75 ton
Right trailing	0·31 ton

All revolving weights balanced in their respective wheels. 10 per cent. reciprocating weight balanced in leading and trailing wheels and 20 per cent. balanced in intermediate wheels, making 40 per cent. of reciprocating weight balanced.

1920. It shows, as the author said, "an irregular line which very closely follows the average torque." An even more important question is that of balancing and hammer blow, and we are particularly glad to be able to give the diagrams on the preceding page.

The balancing of the engine has been worked out in accordance with Professor W. E. Dalby's method. The procedure employed can be followed from the balancing diagrams, the couple and force polygons, and the data presented in the accompanying tables. All the revolving weights are completely balanced in their respective wheels, the whole of the coupling-rods and two-thirds of the connecting-rods being considered as revolving weights. In the case of the reciprocating weights, a compromise has, as usual, been made between complete balancing—which results in a large variation in the rail pressure—and an absence of balancing—which may produce among other effects a dangerous swaying couple at high speeds. The compromise chosen is to balance 40 per cent. of the reciprocating weights. This percentage, it may be noted, is somewhat smaller than that commonly adopted for British locomotives, namely, round about 66 per cent.; but after experience of reducing the proportion, Mr. Maunsell is convinced that 40 per cent. is enough, if not too much. By decreasing it still further, still less hammer blow would result. It is a matter for conjecture how many locomotives are balanced "according to plan."

The reciprocating weights involved in the balancing calculations are the outside and inside pistons, piston-rods, crossheads, pins and arms, one-third of the outside and inside connecting-rods, and one-half the vacuum pump rod and piston; 40 per cent. of these weights is taken, and of that percentage one-quarter is balanced in the leading wheels, one-half in the intermediate wheels, and one-quarter in the trailing wheels. Actually, there are no reciprocating weights associated with the trailing wheels, while on the leading and intermediate wheels they are very nearly equally divided. The distribution of the balancing of the reciprocating weights among all three pairs of wheels has for its object the usual one of reducing the cyclical variations of the rail load beneath the driving wheels. The reduction is effected at the expense of producing a variation in the rail load beneath the trailing wheels with which all the weights actually associated, being purely revolving, can be completely balanced, and therefore be made by themselves to produce no variation in the rail load.

The couple and force polygons follow the usual construction. Each side of any one of the polygons represents to scale the sum of the masses or mass moments acting on the wheel named at the angle at which the side is inclined. The horizontal side of each polygon represents the sum of the left-hand outside reciprocating and revolving masses or their equivalent mass moments. All the other sides are set out at angles measured from this side as zero. Each polygon, whether for a left-hand or a right-hand wheel, includes the masses or mass moments associated with the wheel named and with those of its fellow on the same axle.

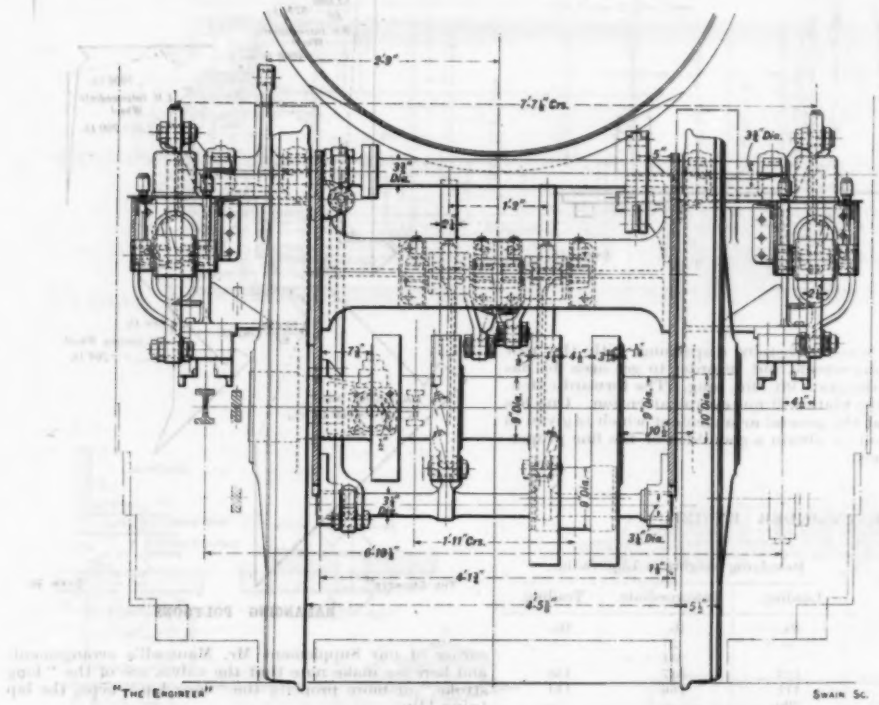
Attention may perhaps be directed to the fact that there is a considerable and unusual difference in the balance weights in the two leading wheels, that in the left-hand wheel being 664 lb. at the crank radius, and that in the right-hand wheel being not much more than half this amount, namely 362 lb. A similar but smaller difference is to be noted in the balance weights of the intermediate wheels, namely 1000 lb. in the left-hand wheel and 929 lb. in the right-hand wheel. In the trailing wheels the difference persists, the weight in the left-hand wheel being 335 lb. and in the right-hand wheel 305 lb. This inequality in the balance weights between the two sides of the engine arises from the non-symmetrical angular distribution of the crank pins. While an engine of this description is not likely to be run backwards for any length of time at any speed, the question may be asked whether, if it were, the inequality would affect the balancing and make it less perfect in the backward than in the forward direction.

It is also worthy of note that the hammer blows, as calculated for a speed of 60 miles an hour, are relatively small—a fact which results from the relatively small percentage of the reciprocating weights which is balanced—but that there is a considerable variation among them from wheel to wheel. The hammer blow is the vertical component of the centrifugal force of that portion of the balance weight concerned with the balancing of the reciprocating parts. Its value therefore varies with the square of the speed, but even at 60 miles an hour the maximum hammer blow in this case, namely, that arising from the left-hand intermediate wheel, barely exceeds 1½ tons. It will be noticed that the blows in the left-hand wheels are in all three instances about 2½ times as great as those in the right-hand wheels. This fact suggests that the engine will re-act on the left-hand rails more severely than the right-hand; but since the blows are so small, far smaller than usual, this fact is of no material consequence. It also seems to imply that a bigger proportion of the reciprocating weights is balanced in the left-hand wheels than in the right. It would appear that of the total weight of the reciprocating masses, 7, 14 and 7 per cent. respectively are balanced in the left-hand leading, intermediate and trailing wheels, and that 3, 6 and 3 per cent. are balanced in the right-hand wheels.

Marine Oil Engines.*

THE paper on "Marine Oil Engines," which was read by Mr. D. M. Shannon on Tuesday evening last, November 16th, before the Institution of Engineers and Shipbuilders in Scotland, deals with some aspects of the author's work on the design of oil engines. In his introduction, Mr. Shannon expresses the regret that most of the work was done on an engine of a complicated nature, which might be considered a passing type. He hopes, however, that the work described in the paper may be useful in connection with the immediate future development of the marine oil engine. On the question of the final type of reciprocating marine oil engine, the author seems to have no doubt but that the two-stroke double-acting motor will prove to be the ultimate form. He points out that the accumulated experience of to-day no longer suggests that such a statement should be regarded as a prophecy. While the adoption of the two-stroke double-acting principle has simplified the problem of design in many directions, the increase in size of cylinder has often brought about serious liner and ring wear. The great strides which have been made in metallurgy have reduced the problem of the largest oil engine to one of comparative simplicity, but a few remaining defects which may form the subject of straightforward experiment remain to be eliminated. The principal problem which now remains is that connected with the walls surrounding the combustion chamber. It involves, in order of importance, the cylinder liner, its cover and piston, and, in the case of a lower combustion space, the piston rod. In the earlier part of his paper Mr. Shannon gives details and calculations for a liner designed for an opposed-piston type of engine in which use is made of a shrunk-on reinforcing member, with a system of diagonal cooling grooves arranged between the two members. In the course of a lengthy section on liner and ring wear the author discusses the effect of such factors as the quality and quantity of lubricating oil, the manner of its application, liner and ring material, engine and piston speed, heat and pressure stresses, the position of the first ring, pressure on and behind the rings, and general design and construction. In the section of the paper devoted to cylinder covers, the author illustrates a simplified method of rendering the seats of valve housings tight against cylinder pressures, and details are also given of an improved form of compressor cylinder head in which the number of component parts is greatly reduced.

* Institution of Engineers and Shipbuilders in Scotland—*Résumé.*



CROSS SECTION

On airless injection engines it is customary to fit a fuel strainer near to the fuel injection valve, and Mr. Shannon illustrates a simple type of air and fuel strainer and flame retarder which has proved effective in practice. An interesting part of the paper deals with the question of gaseous oscillations, and the author remarks that very little experimental work on this subject, which can give any help in intelligently controlling oscillation phenomena or placing the subject in a mathematical basis, is on record.

Experiments carried out on a variable speed opposed piston motor are cited to show that resonance effects may be usefully employed in constant-speed oil engines for charging and supercharging the working cylinders. At present, the author points out, the fall from the terminal pressure in the cylinder to atmospheric pressure—which may be about 35 lb. per square inch—is lost, which pressure might be put to use for scavenging purposes on two-stroke engines, with a possible saving of 5 per cent. in fuel consumption. In the case of the four-stroke engine, the efficiency suffers little or no increase, but the oscillation system might be effectively employed for supercharging when overloads are required. On the much-discussed subject of the rival claims of air and airless injection, the author expresses the view that, as the tendency of new design is always in the direction of simplification, it may be assumed that airless injection will before long prevail for all types of engines. He rightly points out, however, that air pulverisation gives the most complete combustion, and therefore the cleanest engine. Mr. Shannon is of the opinion that in any case air injection should be adhered to, until the fuel consumption per indicated horse-power is about the same for both air pulverisation and airless injection on a given type of engine. If the consumption per brake horse-power is the same then the airless injection engine is only saving the work done in the compressor to throw it away in incomplete combustion, which is bad engineering, despite the fact that a simpler engine is produced. The essentials of a good system of airless injection are enumerated, and several design details are discussed. The problem of manœuvring gear is briefly dealt with, and a type of gear is shown which makes it possible to manœuvre engines up to, say, 5000 brake horse-power entirely by hand power.

In the final part of Mr. Shannon's paper some notes are given on the design of propelling machinery for Diesel-electric schemes. The advantages of the system and the gain in cargo space are set forth, and an installation is worked out and arrangement drawings reproduced for a total of 2300 shaft horse-power, four generating units each of 500 kilowatts capacity, and four auxiliary generators of 200 kilowatts capacity being employed. The disposition of the machinery is shown, and the paper closes with a description of the fuel pump and governor controls, which we gather have worked in practice on ships fitted with this type of machinery.

For Diesel-electric systems the author regards it essential to have a good margin of power in the main generating engines, or in heavy weather the main propeller shaft may be slowed down to about three-quarters of its rated power if difficulty is to be avoided.

ENTERTAINMENTS.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—On Wednesday last Sir Charles Parsons, the retiring President of the Shipping, Engineering and Machinery Exhibition, introduced the new President, the Duke of Northumberland, to members of the various committees at a luncheon given by Mr. Bridges in the Connaught Rooms. His Grace, in acknowledging the welcome that was extended to him, made a characteristic speech, in which he spoke in plain terms of the conduct of the coal strike and of the communistic tendency which he saw behind it. Mr. Bridges was able to assure the guests that despite the present conditions of trade, exhibitors were taking space more freely than ever before, and there was every reason to believe that the Exhibition of September, 1927, would be greater than any of its predecessors.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The annual dinner of the Institution of Automobile Engineers was held on Wednesday evening in the Connaught Rooms, and was characterised by the lightness of heart which we associate with this, one of the youngest technical institutions. The guest of the evening was Sir Sefton Brancker, and the President, Mr. H. Kerr Thomas, occupied the chair. There were only two toasts. Sir Sefton proposed the Institution, in a breezy speech, in which he dwelt, naturally, upon the coming triumph of aerial navigation. He was confident, he said, that in five or ten years' time this country would be dominant amongst the nations of the world in air transport as it was in sea transport. As an example of what we were doing, he referred to the section of the huge airship No. 101, which the delegates of the Imperial Conference had seen at Cardington that morning. In the matter of construction it was far in advance of anything made in Germany, for it was both lighter and stronger. The only other toast was that of the guests, which was gracefully proposed by Mr. J. W. Watson.

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.—The annual dinner of the British Electrical and Allied Manufacturers' Association was held at the Connaught Rooms on Wednesday evening, November 17th, when the Earl of Derby, the President, occupied the chair. In proposing the toast, "The National Development of Electricity Supply," Colonel R. K. Morcome, chairman of the Council, said that he had recently attended the World-Power Conference, and the opinion he had formed was that the electrical manufacturers of this country were second to none in regard to design and equipment, and better than any as regards quality. In responding, Sir Douglas Hogg, Attorney-General, remarked that the Government had introduced the Electricity Bill with the object of overcoming the disorganisation of the industry. The Government was of opinion that if the cost of generating current were reduced electricity would be more generally used throughout the country. There was no reason why cheap electricity should not be used in agricultural districts as it was used in other countries. Lord Derby proposed "Our Guests," and, in replying, Sir Alfred Mond referred to the use of electricity in Canada and America. The enormous use of electricity in the homes of Canada had, he remarked, become almost a matter of course. The reason for the concentration of industry in the towns of this country had been the lack of motive power in other parts. Personally, he was an unrepentant optimist as to the future of industry in this country which had large and cheap fuel resources, the utilisation of which was only in its infancy. Mr. H. W. Gepp, chairman of the Migration and Development Commission of the Australian Commonwealth, also responded, and the toast of the chairman was proposed by Sir Philip Cunliffe-Lister.

The Economic Value of Increased Steam Pressure.*

By H. L. GUY.

(*Concluded from page 537.*)

EFFECT OF REGENERATIVE FEED HEATING (*continued*).

THE variation in the proportion of the total heat supplied by feed heaters, both turbine and economiser, is notable. If economisers are subject to the limitation that the temperature of the water leaving them must not exceed about 80 per cent. of the saturated steam temperature, the maximum quantity of heat they can supply is given by the intercept between the dotted line—Fig. 8 *ante*—and that giving the heat supplied by the turbine feed heaters. The line corresponding to the "ideal economiser" shows the proportion shown of heat converted into work is not indicative of decreasing efficiency, because the heat supplied to the steam per kilowatt by the fuel is itself continuously decreasing, as has been shown in Fig. 3. In the early application of regenerative feed heating a single low temperature feed heater was used coupled to a turbine designed in the normal way, and neglecting, in the proportioning of the blading, the influence of such feed heating on both the steam consumption and the quantity of steam passing through the last stages. When feed heating is carried out to the extent we are considering, the proportions of the steam passages in different parts of the machine are very materially modified.

Relatively to a turbine designed without feed heating the steam quantity entering the first stages has to be very considerably increased to compensate for lost work capacity of the steam diverted to the various heaters. The areas through the blading in the early stages must therefore be increased on this account. The fact that a large proportion of the total steam is diverted to feed heaters naturally results in the blade areas necessary in the final stage of the machine being substantially reduced. Fig. 14 shows for various initial pressures how the blade proportions of turbines designed for four-stage feed heating should compare with those of turbines designed without feed heating.

Consider the blading areas of a 20,000-kilowatt turbine designed for an initial pressure of 1200 lb. per square inch with four feed heaters. Then, compared with one designed without feed heaters it will be built up as follows :—

The first one sixth will have blading appropriate to					25,000 kW.
The next	,,	,,	,,	,,	22,500 ,,
,,	,,	,,	,,	,,	20,000 ,,
,,	one-fourth	,,	,,	,,	18,000 ,,
The final	,,	,,	,,	,,	16,000 ,,

The magnitude of the difference is such that it is obvious that the conditions of steam flow in a turbine having blading proportioned on the basis that the feed heaters are in operation will be profoundly modified when it is operated with the feed heaters out of commission and *vice versâ*. As such modifications in the steam flow conditions would result in some loss of efficiency, the turbine should be designed for the internal conditions holding when the feed heaters are in operation. Further, in such cases estimates of steam consumption with feed heaters out of commission must be given with reserve.

EFFECT OF RESUPERHEATING.

When considering the influence of resuperheating on thermal efficiency a change from 700 deg. Fah. to 750 deg. Fah. was made in the total temperature assumed before the stop valve, the latter involving the use of plant designed for a maximum temperature of 800 deg. Fah. This was done in order to review resuperheating under most advantageous conditions, and because this particular refinement would not logically be adopted unless other conditions were pressed to the maximum. In addition to the assumptions common to the former investigations, a pressure loss in the resuperheater and its connections of 5 per cent. was postulated; no allowance was, however, made for loss due to radiation in passing to and from the resuperheater.

As the gain resulting from resuperheating is dependent upon the point in expansion at which steam is taken from the turbine, the way in which this affected thermal efficiency was examined for different pressures, with results plotted in Fig. 15. Of the two series of curves, those shown in chain dotted lines were obtained by making a wetness correction at the rate of 1 per cent. loss in efficiency for 1 per cent. mean wetness in the stage concerned, whilst this correction was omitted in the group of curves shown in full lines. The proportion of the complete expansion which should precede admission to the resuperheater under the most advantageous circumstances, varies with pressure in the manner depicted in the upper portion of Fig. 17. In the lower portion of the figure the maximum gain in thermal efficiency resulting from resuperheating has been plotted against initial steam pressure.

The outstanding feature of the latter curves is that whereas the gain in thermal efficiency resulting from resuperheating, if the full wetness correction is made, is more than one-third greater at 2000 lb. per square inch than at 200 lb. per square inch, the gain at the higher pressure is only one-quarter that at the lower if this correction is omitted.

Now, while many tests have shown that the usual rate of correction for wetness gives results in conformity with experience with normal high-pressure condensing turbines, such experience as has been accumulated on resuperheating installations to date indicates results not in conformity with predictions on this basis. Whether this follows from the fact that with resuperheating the effect of wetness is less important than this rate of correction would suggest, or whether it follows from the omission to allow sufficiently for other factors entering into the question, is a matter on which the author is not prepared to commit himself in the present state of knowledge. The fact, however, remains that, judged by results at present available, the gain due to resuperheating does not exceed the mean estimated on the two bases under discussion.

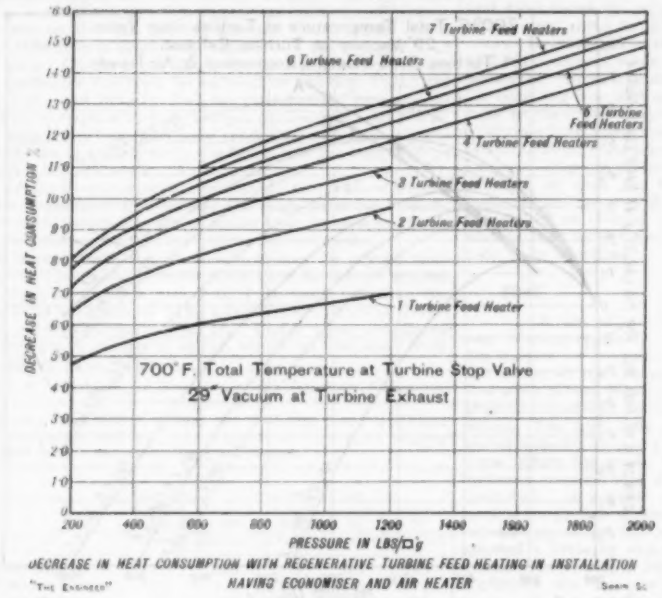

7 Turbine Feed Heaters
6 Turbine Feed Heaters
5 Turbine Feed Heaters
4 Turbine Feed Heaters
3 Turbine Feed Heaters
2 Turbine Feed Heaters
1 Turbine Feed Heater
700° F. Total Temperature at Turbine Stop Valve
29" Vacuum at Turbine Exhaust
DECREASE IN HEAT CONSUMPTION %
PRESSURE IN LBS/□"
DECREASE IN HEAT CONSUMPTION WITH REGENERATIVE TURBINE FEED HEATING IN INSTALLATION HAVING ECONOMISER AND AIR HEATER
"THE ENGINEER"

FIG. 11

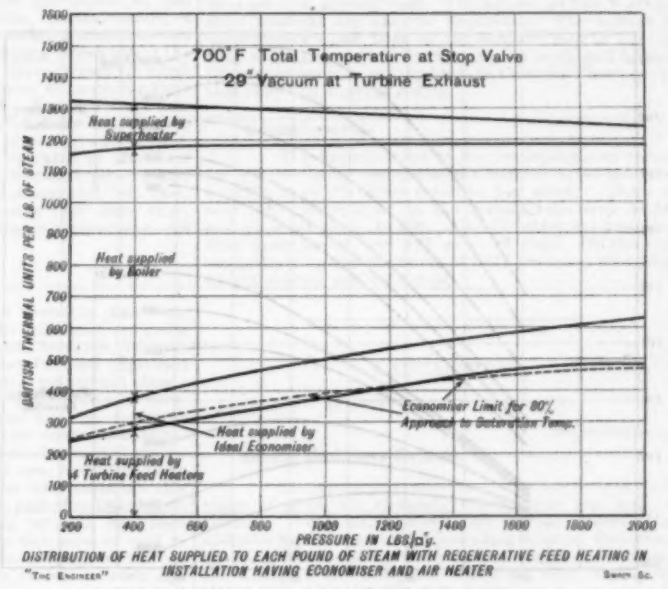

700° F Total Temperature at Stop Valve
29" Vacuum at Turbine Exhaust
Heat supplied by Superheater
Heat supplied by Boiler
Economiser Limit for 80% Approach to Saturation Temp.
Heat supplied by Ideal Economiser
Heat supplied by 4 Turbine Feed Heaters
BRITISH THERMAL UNITS PER LB. OF STEAM
PRESSURE IN LBS/□"
DISTRIBUTION OF HEAT SUPPLIED TO EACH POUND OF STEAM WITH REGENERATIVE FEED HEATING IN INSTALLATION HAVING ECONOMISER AND AIR HEATER
"THE ENGINEER"

FIG. 12

limiting economiser input if water can be raised to boiling temperature.

Figs. 11 and 12 show the corresponding curves for a system in which the boilers are equipped with both economisers and air heaters. The change in the scale to which ordinates are plotted between Figs. 7 *ante* and 11 should be noted. Examination of these results shows that the addition of the air heater increases the improvement in heat consumption resulting from regenerative feed heating between 45 and 58 per cent., or approximately 50 per cent. As compared with Fig. 8 the distribution of the input of heat to the steam shown in Fig. 12 emphasises the decreased range of usefulness of the economiser. If the limitation in maximum temperature of water leaving the economiser is still imposed its range of usefulness has practically disappeared. On the other hand, if water can be heated up to saturation temperature, an important sphere of usefulness is still available to it, as otherwise the amount of heat to be absorbed in the air heater may

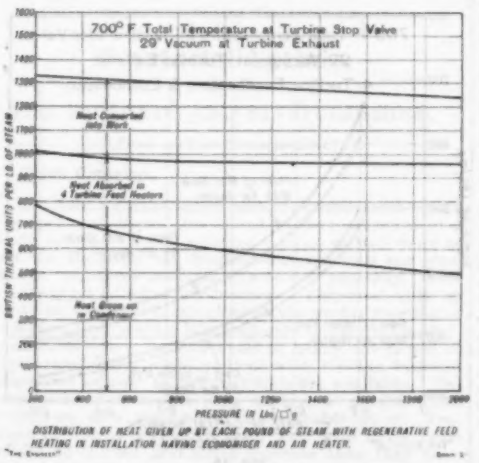

700° F Total Temperature at Turbine Stop Valve
29" Vacuum at Turbine Exhaust
Heat Converted into Work
Heat Absorbed in 4 Turbine Feed Heaters
Heat Given up in Economiser
BRITISH THERMAL UNITS PER LB. OF STEAM
PRESSURE IN Lbs/□"
DISTRIBUTION OF HEAT GIVEN UP BY EACH POUND OF STEAM WITH REGENERATIVE FEED HEATING IN INSTALLATION HAVING ECONOMISER AND AIR HEATER.
"THE ENGINEER"

FIG. 13

prove to result in too high an air temperature for comfortable working. The limitation referred to arises, amongst other things, from a desire to eliminate the possibility of boiling taking place in the economiser, so that an increased field of development is open to those types of economiser which will permit this condition.

The way in which the heat supplied per pound of steam is dissipated is plotted against pressure in Fig. 13, for an installation incorporating four feed heaters, economisers and air heaters. Again, the increasing importance of the function of the turbine feed heaters is apparent, as is also the continuously diminishing sphere of the condenser. It is perhaps necessary to emphasise that these figures relate to a pound of steam and not to the steam required per kilowatt generated. Consequently the diminishing

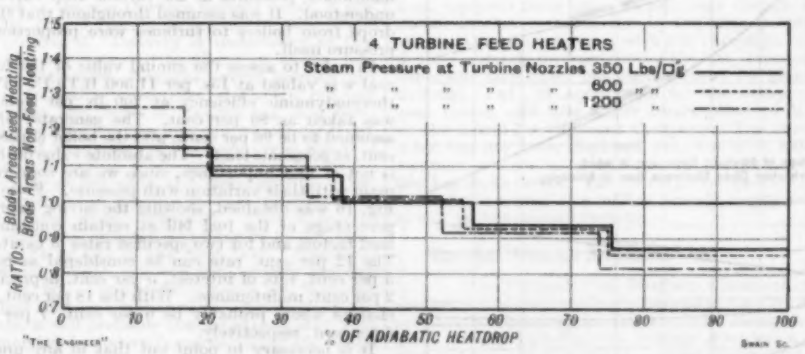

4 TURBINE FEED HEATERS
Steam Pressure at Turbine Nozzles 350 Lbs/□"
600 ,,
1200 ,,
RATIO:- Blade Areas Feed Heating / Blade Areas Non-Feed Heating
% OF ADIABATIC HEATDROP
"THE ENGINEER"

FIG. 14

* Paper read before the North-Western Branch of the Institution of Mechanical Engineers.

sanction. With the conditions assumed, but without resuperheating, the quantity of water present in the steam in the lower stages of expansion increases very rapidly with initial pressure. Thus, with 200 lb. per square inch in itial pressure the fraction of the original steam which is water on leaving the last row of blades is 9·5 per cent.; with 600 lb. per square inch this rises to 15·25 per cent.; and with 1200 lb. per square inch reaches 20·3 per cent. Thus, in such a turbine operating at a load of 40,000 kilowatts, with 1200 lb. per square inch initial pressure—assuming conditions are stabilised from stage to stage—over 33 tons of water per hour are passed through the last blade. In other words, in the terms engineers usually employ to measure such quantities, a stream of 125 gallons of water per minute is hurled into the exhaust.

It has still to be proved by experience whether, at pressures as high as 500 lb. per square inch and above, the erosion which may result from such conditions will set a term to the usful life of the blading which will be sensibly shorter than that usual with more moderate conditions. Should the effect of such erosion prove excessive, but the use of the higher pressures be desirable from other points of view, then resuperheating may ultimately prove a necessary condition for the use of such pressures. Such considerations are believed to have played a part in determining the decision in several cases where resuperheating has been adopted.

The Economic Steam Pressure.

In order to arrive at some indication of the attractiveness of increased steam pressure, consideration must be given to the financial advantages likely to result from its adoption. For this purpose it is necessary to consider the increments in capital costs accompanying the use of increased pressure. Statistics were carefully compiled by the author co-ordinating cost of plant with the variations resulting from increased pressure in the type of plant herein dealt with. A plant characterised by the inclusion of four-stage turbine feed heaters, economisers and air preheaters. For part of the range, many statistics were available, arising from the preparation of a large number of projects; in other cases, special propositions were prepared for the purpose of this paper, particularly when the costs could be arrived at closely from the resources available to the author.

Figs. 8 and 12 are useful in this connection, giving as they do the quantity of heat to be transmitted in the more important elements of the plant. Thus, Fig. 12 shows the distribution of the heat to be taken out of the steam by feed heaters and condensers in the particular case we are considering. It may be of interest to point out, as an example of the kind of factors involved, that the average mean temperature difference in the four feed heaters is 1·92 times that in the condenser for the 200 lb. per square inch installation, rising to 2·46 times for a 1000 lb. per square inch installation. On the other hand, the mean cost of feed heater surface per square foot in the 1000 lb. per square inch installation is 2·5 times that of the condenser surface.

Again, while the total cost of the condenser plant per kilowatt capacity continuously decreases with initial pressure, that of the feed heaters is continually increasing so that the combined cost at first decreases slightly, then takes an upward trend. The cost of the turbines themselves continuously increase with pressure, so does the combined cost of the boilers, economisers and preheaters. On the other hand, the cost of the boiler-house decreases.

The total increased capital cost per kilowatt installed at economic rating was found to be not less than that given in the following table :—

Increase in Capital Cost per Kilowatt with Increasing Initial Pressure at the Turbine Stop Valve.

Pressure, lb./sq. in. g.	Increased cost per kilowatt. £
200	0
300	0·158
400	0·358
500	0·600
600	0·884
700	1·211
800	1·579
900	1·990
1000	2·443

In this table the costs above 800 lb. per square inch g. were obtained by extrapolation. When pressures are mentioned, pressures at the turbine stop valve are to be understood. It was assumed throughout that the pressure drops from boilers to turbines were proportional to the pressure itself.

In order to assess the annual value of the fuel savings coal was valued at 15s. per 11,500 B.Th.U. The turbine thermodynamic efficiency at 200 lb. per square inch g. was taken as 89 per cent. The generator efficiency is assumed to be 96 per cent., and the boiler efficiency 84 per cent. at economic load. The absolute value of these figures is not of first importance, since we are concerned in the main with their variation with pressure. From this basis, Fig. 16 was obtained, showing the saving expressed as a percentage of the fuel bill at certain constant machine load factors and for two specified rates of capital charges. The 12 per cent. rate can be considered as made up of 5 per cent. rate of interest, 5 per cent. depreciation, and 2 per cent. maintenance. With the 18 per cent. rate these charges would probably be 6 per cent., 7 per cent., and 5 per cent. respectively.

It is necessary to point out that in any one year the machine load factor is necessarily less than the station load factor. Further, the machine load factor which must be taken is the average actual output of the machine for the whole redemption period necessary at the cohsen rate of interest to wipe out the capital invested, divided by the maximum continuous rating of the set. The locus of the maximum points shown by curve A was checked by arriving at the expressions which corresponded with the ascertained capital cost per kilowatt installed, and the annual fuel saving, thus obtaining the net saving and differentiating.

The expressions were found to be as follows :—

Net saving in pounds sterling per annum =

$$l\left(0{\cdot}610 - \frac{189}{p + 110}\right) - r\left(\frac{2{\cdot}11}{10^5}\,p^2 + \frac{5{\cdot}22}{10^4}\,p - 0{\cdot}1888\right)$$

$$= l\,\mathrm{F} - r\,\mathrm{C}.$$

Where l = machine load factor.
p = pressure adopted in lb. per square inch g.
r = rate of capital charges.

The first term in brackets F represents the annual value per kilowatt of the fuel saving with 100 per cent. load factor. The second term in brackets C represents the value per kilowatt of the additional capital cost. Fig. 18 has been plotted co-ordinating the pressures, corresponding to maximum return on additional investment with the ratio r enabling results for other load factors and rates of interest than those adopted in Fig. 16 to be obtained readily.

Table IV.—*Pressure for Maximum Gain, lb./sq. in. g.*
Expansion from 700° F. to 29in. vac. with four feed heaters and economiser, and with and without air heater, at varying load factors and rates of capital charges.

	Rate of capital charges. Per cent.	Load factor. 100 per cent	60 per cent	50 per cent	30 per cent
With air heater ..	12	606	495	459	367
Without air heater..	12	575	466	433	350
With air heater ..	18	516	417	385	306
Without air heater..	18	477	396	366	293

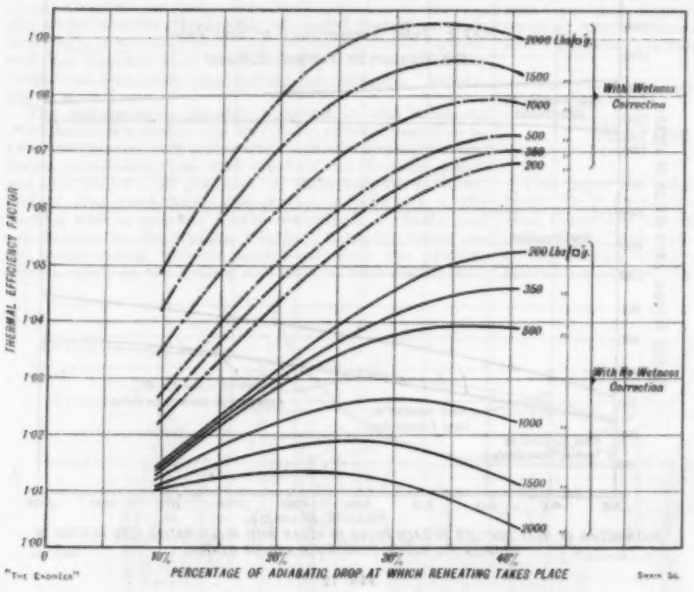


FIG. 15

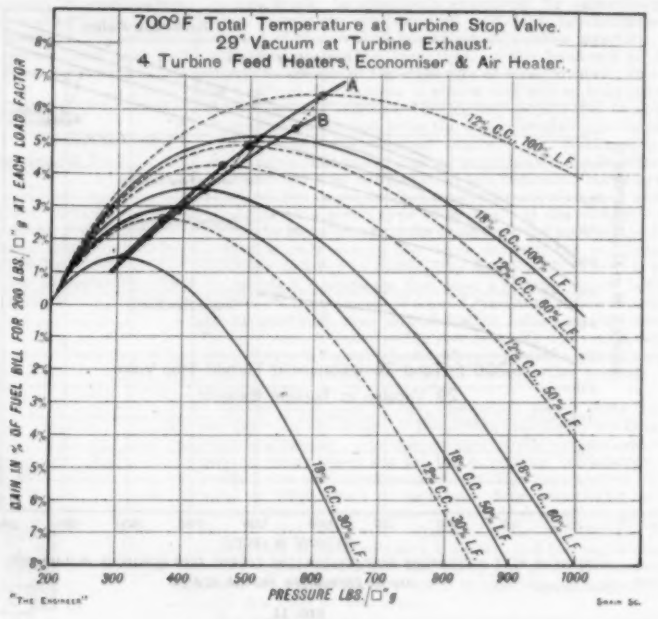


FIG. 16

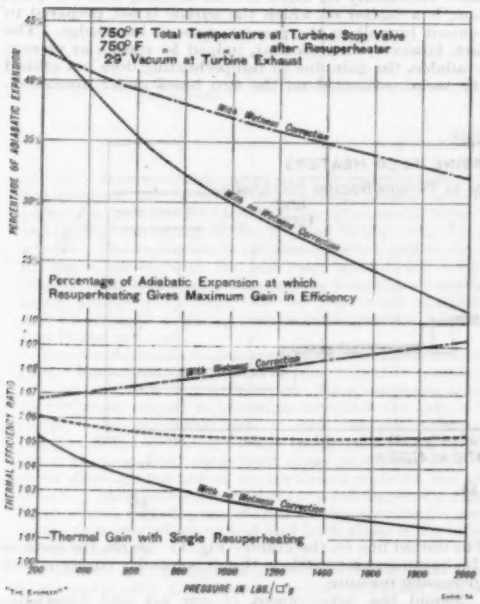

750° F Total Temperature at Turbine Stop Valve
750° F " after Resuperheater
29" Vacuum at Turbine Exhaust
PERCENTAGE OF ADIABATIC EXPANSION
With Wetness Correction
With no Wetness Correction
Percentage of Adiabatic Expansion at which Resuperheating Gives Maximum Gain in Efficiency
THERMAL EFFICIENCY RATIO
With Wetness Correction
With no Wetness Correction
—Thermal Gain with Single Resuperheating
PRESSURE IN LBS./□"g
"The Engineer"

FIG. 17

The net annual gains for other costs of fuel can be obtained by making use of the relation that the gain is constant if the price of fuel multiplied by the load factor is constant. Thus, the curve in Fig. 16 relating to coal at 15s. per 11,500 B.Th.U. and 100 per cent. load factor holds also for coal at 30s. per 11,500 B.Th.U. if the load factor is 50 per cent. Curve A gives the locus of the maxima for installations which include an air heater and economiser, whereas curve B gives the corresponding points if the air heater is omitted.

Reverting to Fig. 16 it will be found that the pressures at which the maximum return is possible vary with the load factors as follows in Table IV.

At this stage it is desirable to review certain of the bases of the investigations which have led to this result.

(*a*) In considering the effect of steam pressure on certain of the turbine losses a rate was employed which experience has shown can be obtained under favourable conditions for the range from 200 lb. per square inch to 350 lb. per square inch plant in of relatively large capacity. It is doubtful if the rate would be kept down to this limit for further increase in pressure.

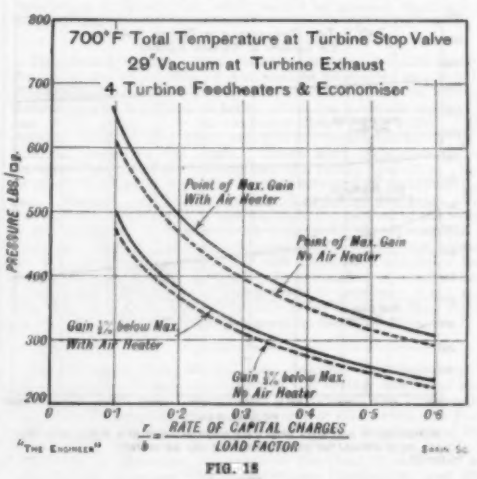

700° F Total Temperature at Turbine Stop Valve
29" Vacuum at Turbine Exhaust
4 Turbine Feedheaters & Economiser
PRESSURE LBS./□g.
Point of Max. Gain With Air Heater
Point of Max. Gain No Air Heater
Gain ½% below Max. With Air Heater
Gain ½% below Max. No Air Heater
r/b = RATE OF CAPITAL CHARGES / LOAD FACTOR
"The Engineer"

FIG. 18

(*b*) The rate of maintenance and depreciation has been assumed constant with pressure; experience has still to determine whether this is justifiable above 350 lb. per square inch.

(*c*) It has been assumed that the percentage time the plant is available for service is independent of the initial pressure adopted.

(*d*) It has been assumed that increased pressures will not necessitate the use of resuperheating in order to keep down deterioration from increased erosion inside the turbine as the initial pressure is increased. Should resuperheating prove necessary for this reason, the capital charge will be increased as a result more than sufficiently to counterbalance the resultant saving in fuel cost.

(*e*) One of the elements improving the gain in thermal

efficiency with pressure-regenerative feed heating—has been discussed as carried right to the point of maximum efficiency. Further, it was also assumed that air preheating was carried to such a point that the air heater absorbed sufficient heat to maintain the boiler efficiency constant.

These two considerations can, in a normal installation, be shown to require the temperature of the air leaving the preheater to be about 392 deg. Fah. for 1000 lb. per square inch initial pressure, 330 deg. Fah. for 600 lb. per square inch, if it is 250 deg. Fah. for 200 lb. per square inch, thus leaving the economiser with very little to do. It is questionable whether under such conditions the average operating boiler efficiency can be prevented from decreasing as pressures are increased. For such reasons, these kinds of additions to simple plant are not usually pressed beyond the point where the gain resulting from their use ceases to be sensibly changing.

For instance, regenerative feed heating can, with advantage, be stopped at temperatures 40 deg. Fah. less than those corresponding with maximum gain in efficiency. The loss on the feed heating account, which would result from this drop in final temperature is of the order of 0·15 per cent. On the other hand, the air temperature leaving the preheater can then be reduced to 346 deg. Fah., 284 deg. Fah., and 205 deg. Fah. for initial steam pressures of 1000 lb. per square inch, 600 lb. per square inch, and 200 lb. per square inch respectively, and the usefulness of the economiser as measured by the fall in flue gas temperature across it is increased by 25 per cent.

(*f*) At present there are limitations to our knowledge of the properties of steam at the high pressures, which, when removed, may show either that the possible gains have been assessed at too high or too low a rate.

Balancing these considerations it may be argued that at present increased pressure should not be carried beyond the point at which a saving of ¼ per cent. less than the maximum is obtained. The locus of such points is shown in two lower curves in Fig. 18. Under these conditions the maximum pressures which would be obtained from Fig. 18 are as in Table V. :—

TABLE V.—*Pressure for Gain ¼ per cent. less than Maximum, lb./sq. in g.*

Expansion from 700° F. to 29in. vac. with four feed heaters and economiser, and with and without air heater, at varying load factors and rates of capital charges.

	Rate of capital charges. Per cent.	Load factor. 100 per cent	60 per cent	50 per cent	30 per cent
With air heater ..	12	460	379	355	285
Without air heater..	12	439	363	345	275
With air heater ..	18	394	325	300	238
Without air heater..	18	378	312	289	227

This investigation has been presented throughout in such a way that the effect of any variation in the bases can be readily ascertained.

It is but natural to suppose that in the ordinary process of engineering development the ratio of increased cost of the plant for generating and utilising increased pressure will tend to decrease. On the other hand, average machine load factors and perhaps the price of fuel will tend to increase. Such changes will, of course, affect the values of the economic pressure which can, at any time, be readily ascertained from the diagrams included in this paper.

In conclusion, the author wishes to express his thanks to the Metropolitan-Vickers Electrical Company, Ltd., for permission to draw on its resources, and to the various gentlemen who have assisted, and in particular to Mr. D. M. Smith, B.Sc., Mr. G. W. Higgs-Walker, B.A., and Mr. A. Stubbs, B.Sc., for help in the voluminous calculations necessary in the preparation of the diagrams.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Trade Optimism.

THE welcome imminence of a settlement of the prolonged coal dispute has raised widespread hopes of a speedy return to trade activity. In no district more so than the Midlands and Staffordshire are iron and steel masters, engineers and manufacturers generally, more anxious to get on with their business. Eagerness to be up and doing was most pronounced at the weekly meeting of the Midland iron trade in Birmingham—to-day—Thursday. On all sides was to be heard talk of heavy orders and of preparations being made to deal with the big business anticipated as soon as raw materials are available. Inquiries were in circulation as to the nearest possible dates for delivery after resumption and probable prices. Producers of iron and steel on their side were much more inclined to discuss post-strike business than they have been of late, and it is anticipated that orders for raw material for delivery in January would be accepted by most mills and furnaces. It will, of course, take some considerable time to get the big steel works back into working order, and few of them give much hope of a resumption before Christmas. In most of the Midland industries there are indications of a real boom in trade. Many of the heavy industries are only waiting the possibility of securing normal supplies of fuel to pass into a period of prosperous activity. A vast accumulation of orders has been piling up since May, and their execution will keep the iron and steel and heavy engineering industries busy for months. Activity of that kind will be reflected in many subsidiary industries. Iron and steel masters' order books generally are so improved that they are confident of substantially increased outputs. Moreover, there is likely to be enormous new business booked in the near future. It is remarked, however, very forcibly, that trade requires cheaper coal than it has had since the war for its sound and progressive development. There are opportunities for enterprise which cannot be exploited if the basic industries, as the result of high fuel costs, are prevented from competing effectively with their continental rivals.

Staffordshire Activity.

Fresh endeavours are being made in South Staffordshire to get the production of structural steel started again. The success of these efforts must depend, for the moment, upon the amount of fuel available from affiliated pits. It is an encouraging sign, however, that, without waiting for a settlement of the mining dispute, some industrialists should have been emboldened to restart plant that has been standing idle for months past. Operation costs will, until the impediments in the coal mines are removed, be heavy, and in the most favourable circumstances, some time must elapse before market equilibrium can be restored. There is urgent work, however, which must be pushed forward as quickly as possible, irrespective of the additional cost which may be entailed. Users of iron and steel to whom supplies are vital will expect to pay exceptional rates for their materials. Plants cannot, of course, be restarted at the present swollen production costs to fulfil contracts made at normal selling prices before the upheaval. Foundrymen are now paying twice as much for their pig iron and more than twice as much for their coke as they were paying in April. Not only have raw materials from home sources advanced, but when recourse is had to foreign supplies increased prices have to be paid. In other respects plants are being operated at abnormal expense, so that the high prices required for finished material are not merely the result of scarcity. At best, the return to normal production must take some time, and as long as demand exceeds supply forbearance will have to be exercised.

Steel.

A few of the Staffordshire re-rolling plants are now running regularly. Most of the mills that are going are subject to frequent interruptions, however, through the failure of the fuel supply. A hopeful view expressed this week is that from now onward the output will show a gradual expansion. There are heavy arrears to be overtaken. The high cost of production and the desire to accommodate customers with whom they contracted obligations before the strike are causing producers and manufacturers considerable worry. They are, however, doing their best. A notable change in the steel situation this week is the greater willingness on the part of mills to quote for delivery after the strike. This attitude has been assisted a little by the reduction in the price of coal in several districts to a level of £2 10s. per ton, which has confirmed the impression strongly voiced a week ago that peak prices for iron and steel commodities as well as for fuel have been reached. The promises of delivery after resumption at an agreed price is a nearer approach to definite business than has been seen for some time. New business naturally can be placed only at prices substantially higher than those which ruled before the strike. For angles £8 to £8 12s. 6d. is quoted. The price for prompt delivery remains at £9 10s. Ordinary plates are offered at £8 18s. 6d. Narrow working-up strip realises £10 10s. to £10 15s. It is now almost impossible to get promises of early delivery of steel from the Continent. Prices have eased a little. Mild steel bars are down 2s. 6d. per ton, making them £5 14s. 6d. at port, or about £7 delivered. Joists command £7 delivered. Billets are offered at from £6 7s. 6d. to £6 10s. Continental supplies are still subject to serious delay.

Pig Iron Stringency.

The severest stringency still prevails in pig iron, which is produced only in very trifling quantities. It is difficult to get any promises of delivery from any part of the country. Apart from very meagre remnants of special iron, including cold blast, there is no native pig available outside the North Country. Cleveland prices remain at the high level to which they advanced a few weeks ago. For the output of the one Durham furnace which is producing foundry pig £6 16s. 3d. is quoted for No. 1, and £6 11s. 3d. for No. 3. Delivery is undertaken in four weeks, but sales are restricted to 25-ton or 50-ton lots. Hematite is unobtainable, furnaces having scarcely any reserves left. Increasing quantities of foreign pig iron are being bought, any hope of English pig iron being supplied this year now approaching the vanishing point. It is realised that the restart of the coke ovens will be a slow business, and further weeks must elapse before pig iron is obtainable of the right and usual quality. Consumers are consequently placing forward business with the Continent much more confidently. They appear to think that continental supplies will have to be depended upon for a month or two in the New Year. Merchants this week offered French pig iron for January delivery at about £5 12s. 6d. Continental supplies are, however, to be had at half a crown less than that. Although £5 10s. is a high figure, it will probably compare favourably with the price demanded by native furnaces during the initial stages of resumed output.

Galvanised Sheets.

The galvanised sheet trade is busy, and this week mills have further advanced their quotations 5s. per ton. Most sellers now require £17 15s. for galvanised corrugated sheets of 24-gauge, and there are mills exceptionally well placed which quote up to £18. For the most part continental steel is being utilised by the mills, and considerable interruption in production has taken place as the result of intermittent arrivals of this material. There is still no lack of orders even at the current high figure.

Production.

It is considered by industrialists hereabouts most satisfactory that, although during the past month it has been impossible to put into blast any additional furnace, the production of pig iron has increased. At the end of October five furnaces remained in blast, compared with 147 blowing on the eve of the coal stoppage. Production of pig iron amounted to 13,100 tons, compared with 12,500 tons in September, 539,100 tons in April, and 473,700 tons in October, 1925. Steel production, on the other hand, shows a slight decline, amounting, as it did, to 92,900 tons, compared with 95,700 tons in September, 661,000 tons in April, and 652,400 tons in October, 1925.

Midland Miners.

The coal dispute is virtually over in the Midlands. Cannock Chase and Warwickshire have decided to accept the Government's settlement proposals, and at a meeting of the West Midland miners it was decided that as 80 per cent. of men in the area had returned to work, those at the meeting could not accept the responsibility of accepting or rejecting the settlement proposals. Simultaneously with the acceptance of the proposals there has been an increased drift back to the pits. In each of the areas mentioned large increases in the number of miners at work are reported. At Cannock Chase, at the time of writing, practically 20,000 out of 25,000 miners in the area were working in the mines, and, as stated above, over 80 per cent. of the normal number employed in the West Midland area are now getting coal. The figures for the Warwickshire coalfield are likewise improving. The miners are undoubtedly quite tired of the dispute, and it is hoped they will now put their backs into the work and increase the output per man as they have, in Cannock Chase, proved that they can do if they wish.

Unemployment.

The improvement in the unemployment returns for the Midlands continues, the current total being less by 1476 than the figure recorded last week. There are now fully unemployed in the Birmingham area 38,549, and on short time, 10,800. The Coventry returns show 5074 unemployed, and 193 on short time. Of the total unemployed in the Midlands 139,127 are men, 3104 boys, 44,383 women, and 4653 girls.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

Textile Machinery Exports.

SHIPMENTS of textile machinery last month to the value of £848,692, although much below the level of October, 1925—£1,021,938—were rather more than £200,000 higher than in the preceding month. Exports of spinning and twisting machinery accounted for almost the whole of the difference compared with September, they being valued at £660,645 in October, compared with £482,816 in September. A slight increase was also shown in the case of weaving machinery. The weights of the exports of all classes of textile plant exported in the two months were 8169 tons and 6885 tons respectively. The shipments to the Dutch East Indies were responsible for nearly 25 per cent. of the total value, the exports there being £203,901. The second largest individual buyer was Russia with £105,182, followed by Japan with £95,251, South American countries £73,695, the United States £46,313, the Netherlands £38,856, Germany £30,960, Australia £27,094, France £26,321, and China £24,899, "other European countries" collectively taking textile machinery in October to the value of £138,214. The exports during the first ten months of this year are valued at £8,158,962, compared with £10,074,582 in the corresponding period of last year, and £8,906,431 in the first ten months of 1924

A Big Australian Order.

Cotton-growing developments in Australia during recent years and the interest that has been shown there in the manufacture of cotton textiles has led to a steadily increased demand for textile machinery. Already this year plant to the value of nearly a quarter of a million has been exported from this country, and though the Australian market is much less in importance than many others, it is the only one, with the exception of Russia, to show a steady increase during the last three years. An important new order has been secured by Howard and Bullough, Ltd., of Accrington, for the equipment of a large cotton mill now under construction in Melbourne by the Astral Development Company. The value of the order has not been disclosed yet, but it is believed to represent a substantial addition to the work which the firm has on its books. The Astral Development Company, which has a capital of a million pounds, combines British as well as Australian interests.

The Coal Products Exhibition.

The National Coal Products, Chemical and Engineering Exhibition, which was opened at the City Hall here on Tuesday afternoon by Captain F. W. Bain, although it has a special appeal to the coal-tar distillation and the chemical industries, is of wide general engineering interest. Makers of plant possessing anti-corrosive properties are well represented, as are also makers of forced draught and smoke prevention appliances for boiler work, boilermakers, manufacturers of air compressors and vacuum pumps, centrifugal machinery, filter presses, low-temperature distillation apparatus for low-grade fuels, boiler feed-water treatment plant, weighing and drying machinery, measuring and recording devices, and laboratory apparatus. Stands are occupied by the College of Technology, Manchester, and the Universities of Leeds, Sheffield and Birmingham, and the results of recent research work carried out there into such problems as smoke abatement and fire damp are being made known. The Exhibition will remain open until Saturday week.

Back to Full Time.

The official announcement was made last week-end that all men employed on repair work at the Horwich locomotive works of the London, Midland and Scottish Railway would resume full-time working on Monday of this week. About 2000 men, representing half of the full complement, are affected by this change. Most of the men employed at Horwich have been working only four

days a week since the beginning of the general strike, and the fact that a similar order has been issued in respect of the Derby works would seem to indicate that there are heavy arrears of repair work to be overtaken.

Personal.

Manchester University Council has appointed Mr. Arthur Riley to be assistant lecturer in textile engineering. Dr. James A. Bowie has been appointed director of the Department of Industrial Administration at the Manchester College of Technology.

Non-ferrous Metals.

Tin has fully demonstrated its ability to recover by the events on the non-ferrous metal markets during the past week, when for the second week values effected a steady climb back towards the position they so abruptly vacated three weeks ago. The tendency at the moment seems inclined to continued firmness, although in this market less than almost any other is it safe under present conditions to attempt to forecast price movements in advance. In view of the fact, however, that recent shipments to the United States have reduced warehouse stocks in this country rather substantially, the position for the time being seems to be all in favour of the "bulls." Copper has been somewhat steadier, and a slight gain in values has been a feature of this market since last report. The trade demand for domestic consumers has been moderate, but there has been only a quiet business done on continental account. The change in the industrial outlook is credited with having had some influence on the market. Both lead and spelter are stronger on balance, and an improvement in home consumption is anticipated when the coal dispute is settled and conditions return to something approaching normal.

Iron.

Conditions on the iron market remain quiet, and the more hopeful prospect of an end to the coal stoppage has had the effect of reducing operations to a minimum, so much from the point of view of prices depending upon the prices that coal is able to command. An early settlement would, of course, bring the latter down very quickly, and there are no users of pig iron who are anxious to continue paying the present high figures that holders are asking for available supplies. The result is that buying is on an exceedingly small scale, although, notwithstanding, it seems to be sufficient to take care of most parcels that come along. Prices have not altered much during the past week, and it seems reasonably certain that any further movement will be decidedly downward. For prompt delivery of Middlesbrough iron about £6 17s. 6d. per ton delivered Manchester is the price for No. 3, with Scottish makes scarce and steady at about £7 per ton. East Coast foundry iron remains at £6 12s. 6d. per ton delivered, and limited offers of off-grade hematites from the same district at £6 per ton. There seems to be little hope now of Derbyshire or other Midland brands of common iron coming on the market before the beginning of next year. At all events, this appears to be the general market opinion. A small amount of bar iron is being turned out by one or two Lancashire makers, for the most part with existing stocks of "semis," and this is being disposed of at a premium of about £1 10s. over the Association prices of £12 10s. per ton for Crown bars and £11 5s. for seconds. Some firms are expected to resume very shortly after the mines reopen.

Steel.

Although the steel market is rather featureless, some firms are already estimating production possibilities, and round the middle of December, providing there is an early general resumption at the mines, has been fixed by one large concern as the date at which it expects to restart delivery from the rolling mills. In the absence of firm quotations for forward business, values are more or less nominal, with joists and sections ranging from £7 17s. 6d. to £8 2s. 6d., ship plates at £8 7s. 6d. to £8 15s., boiler plates at £11 10s. to £11 15s., and basic bars at £8 17s. 6d. to £9 7s. 6d. For early deliveries of re-rolled bars Lancashire makers are holding firm, with offers at about £10 per ton. There is not much business reported just now in galvanised sheets, and inquiry from India is slow, with prices maintained at £17 10s. per ton f.o.b. for 24 gauges. Thin sheets also remain slow. Sellers of continental steels are not meeting with a great deal of buying interest at the moment, and the majority of users seem disposed to "sit on the fence." For delivery to works in the Manchester area, for net cash against shipping documents, Siemens plates are quoted at about £7 15s. per ton, light plates at £7 10s., joists and sections at £6 15s., steel bars at £6 17s. 6d., sheet bars at £6 10s., billets at £6 5s. to £6 7s. 6d., and wire rods at £7 2s. 6d. per ton.

Scrap.

Inquiry for non-ferrous scrap is poor and sales are in small quantities. Scrap lead is easier at £29 10s. per ton, with zinc steady at £25 10s., clean light copper at £57, brass rod turnings at £40, selected gun-metal scrap at £53, and heavy yellow brass at £44 to £45 for graded materials delivered to users' works.

BARROW-IN-FURNESS.

Hematite.

The market continues firm, and what the district is waiting for now is the settlement of the dispute and a normal supply of fuel, so that makers may commence on the delivery of orders which now bulk very considerably. Most of the big customers and agents placed their orders some time ago before prices got so high as they now are, but business has continued owing to other buyers covering themselves. Prices are firm, and, if anything, there is a tendency for them to increase, but trade at present has not a great volume. Some orders for forward delivery extend over a considerable period beginning with the restart. Trade in special qualities is expected to reach considerable tonnage, for inquiries are still being received.

Iron Ore.

Iron ore has been very quiet, but the local mines are likely to experience a better period than they have done for some considerable time. The same remark applies to foreign ores, and it is hoped that the increased freights will not put up the cost delivered at West Coast ports.

Steel.

There is nothing like the same life in the steel trade as there is in iron. Orders are held, but they were mostly placed before the price of iron went up. Fresh business may come when the furnaces are in blast, and when there will be a possibility of stating a time of delivery.

SHEFFIELD.

(From our own Correspondent.)

Steel Prices Advanced.

In view of the enormous increase in production costs, it is not surprising that the prices for billets have been advanced, but even now it is doubtful whether makers will be able to get out without loss. Acid billets have been advanced 20s. and basic billets 10s. a ton, with a further 30s. a ton towards covering the increased cost of fuel. There is a severe shortage of steel for the heavy trades, and although at the time of writing it looks as though work at the mines will be fully resumed without much more delay, the immediate prospect for the iron and steel trades is not promising. I suggested last week that there would not be much steel produced in Sheffield before the end of the year, and that view is confirmed by later information. The great works at Templeborough and Ickles, it is now certain, will not attempt to re-start the plants this year. In fact, with the Christmas holidays demanding another stoppage, it would be almost impossible to start before, even if the necessary fuel, pig iron and scrap were at once available. It is true that there is a vast accumulation of orders for the heavy trades awaiting completion, and when the works do get going again they will be busy for a considerable period. At the same time there is not room for too much optimism. Contracts for billets for delivery after the settlement have already been agreed to at 10s. a ton more than the old rates, and pig iron, coal and coke are also figuring at higher rates in new agreements that are being made. All these things, and the inevitable allied factors, are going to make it increasingly difficult to meet foreign competition—which, by the way, threatens to become keener than ever.

Engineering Departments.

The engineering trades are heavily handicapped because of the lack of material and the high prices that have to be paid, but in spite of that the works are remaining wonderfully active. Hadfields, Ltd., had to suspend a thousand men in its foundry last week, owing to lack of materials, but the difficulty was surmounted during the week-end, and on Monday all the men were able to sign on again. Sheffield firms have been invited to tender for 526 pairs of finished cast steel solid spoke wagon wheels, complete with axles and tires, and 148 steel disc wheel centres for the Great Southern Railway, Ireland, and for 690 tons of mild steel angles, flats, rounds and squares, and about 180,000ft. of railway signal point rodding of plugged tubing for the India Store Department. On Monday full-time employment was resumed in the chief mechanical engineer's department of the London, Midland and Scottish Railway works at Derby, where between 3000 and 4000 men have been on short time since the general strike. There is considerable interest for Sheffield in the announcement that Vickers Ltd. had received a contract for the conversion of two steamers into troopships, referred to last week by your Barrow correspondent, because the River Don Works always stand to benefit from work of this description. The Brightside Foundry and Engineering Company has produced at its Newhall Works, Sheffield, an anvil which is one of the largest ever cast. It measures 10ft. by 8ft. 6in. by 7ft. deep, and weighs about 90 tons. It has been made for use at the Kirkstall Forge, Leeds.

The Spanish Steel Decree.

Some weeks ago I referred to the campaign which has been started by the Sheffield Chamber of Commerce to get a boycott of Spanish wines and fruits by way of retaliation to the Spanish Royal Decree, which bans the importation into Spain of special alloy steel from Sheffield. This decree has caused much comment, both in this country and in Spain. The threatened boycott has evidently drawn the attention of some persons in Spain to the injustice that is being done to this country, for among the information that has reached the Sheffield Chamber of Commerce is a cutting from a Spanish paper. In this a contributor wrote: "It is of the greatest interest to bear in mind the importance of the campaign now being waged in England, and certainly with some reason, on account of the Royal Decree regarding the importation into Spain of English steel. It is a matter of life and death to us, and if the English campaign is continued without any remedy on our part and unless the Government comes to an arrangement, ruin is imminent. Therefore the Association of Exporters of Wine and the Exporters of Fruit should come together so that without loss of time they may arrive at a common agreement to petition the Spanish Public Powers to study public interest and propose to the English Government a solution which will prejudice neither side."

Tools, Plates and Cutlery.

Some variation exists in the conditions of the tool trades, but on the whole the position is satisfactory. There is a good inland and export call for saws, and for these, as well as other classes of steel tools, there appears to be an increasing demand. There is every prospect that this activity will continue well into next year. The export of tools from Sheffield last month was down by comparison with the corresponding month last year, but the drop is not nearly so much as might have been expected in view of the prevailing conditions. The exports of cutlery for the ten months of this year were of the value of £838,074, or a drop of only £50,000 on the value last year. Safety razors and blades exported last month were of the value of £21,000, and for the ten months £125,000. As this is a comparatively new Sheffield trade and big efforts are being made to capture the world's markets, great interest is naturally being taken in the export figures. The trade in plate and cutlery is still on the decline, and the bulk of the works are on short time. There has been a big decline in the demand for stainless knives. The Cunard Steamship Company is inquiring for delivery of about 6000 table knives, forks, fruit and fish eaters, and spoons, all in best electro-plate. Tenders are also invited by the Irish Free State Government for supplies of cutlery and plate, valued at several thousand pounds, for the Army. Here, again, the highest quality of electro-plate is specified. Last week there was an item of bad news for those trades which make extensive use of electricity, Sheffield Corporation deciding, in view of the fact that it was losing at the rate of about £20,000 a month because of the high price paid for coal, that the scale of charges would have to be raised.

The Fuel Position.

It cannot now be said that there is any pronounced shortage of coal in this district for the priority services. More men have gone back to the pits, particularly since it has appeared clear that a settlement would soon be reached, and the output from the collieries in West and South Yorkshire, as well as in the adjoining areas of Nottinghamshire and Derbyshire, has reached considerable figures. The maximum price at the pits has been fixed at 50s. a ton. The production of outcrop coal has been somewhat retarded by the wet weather and certain contractors, supplying for industrial purposes, have been unable to deliver quantities according to their terms. Westphalian coke is being largely used by the crucible steel makers, though two collieries in this district have begun to make steel coke in their patent ovens. It is estimated that since the commencement of the dispute more than 100,000 tons of continental coke have been brought into Sheffield to help on industry.

Ship Canal Project.

Colonel Somerville, of Doncaster, Clerk to the Hatfield Chase Commissioners, has called a conference at Doncaster for November 23rd, to consider the question of constructing a ship canal to Doncaster, and possibly to Sheffield. The invitation to attend the conference has been sent to twenty influential people in South Yorkshire representative of mining and drainage interests, the Federation of British Industries and local government officials. The object of the conference will be to see if it is not possible to prepare a definite scheme to lay before the Royal Commission on Mining Subsidence when it holds its public inquiry next January. Major G. R. Peake, the chairman of Hatfield Chase Commissioners, put forward a scheme early this year in which he suggested the idea of a combined drainage and navigation scheme in a ship canal from the Trent Falls to Doncaster, and even to Sheffield. Major Peake consulted Mr. Korthals-Altes, an eminent Dutch engineer, who, after a thorough survey of the ground, agreed as to its practicability. I dealt with Mr. Korthals-Altes' report in some detail at the time.

Railless Trams Favoured.

Rotherham Borough Council is to seek a provisional order for the purpose of co-operating with the Mexborough and Swinton Tramways Company in its proposed extension of the railless system of trams. The company has power to run railless vehicles from Manvers Main to Conisborough, and it desires to get powers to run into Rotherham, where there is at present a rail system between that town and Mexborough. Rotherham Corporation has made terms whereby it will do away with its tramways to the borough boundary and substitute railless, thus joining up with the Mexborough company, who will also cease to use the rail method. The company is scrapping plant to the value of £100,000, and installing railless vehicles at a charge of £60,000. The cost to the Rotherham tramways department is estimated at £8000.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Position in Northern Coalfields.

THERE is a strong feeling in Northern trade circles that the miners voting upon the Government memorandum will be in favour of ending the coal stoppage, which has had such disastrous consequences to industry generally. Few areas have been so badly hit by the prolongation of the dispute as the North of England, and it is now recognised that great problems have to be faced in order to recapture the markets that have been lost. Given an assurance of industrial peace, however, manufacturers are optimistic enough to believe that trading conditions will quickly be established on a sound basis, and that there will be a brisk period of activity. Orders in hand and inquiries that are circulating guarantee a good start in the iron and steel trade, and further expansion is foreshadowed by the revival in the shipbuilding industry. Some weeks, however, must elapse after the settlement of the dispute before it is possible to rekindle the blast-furnaces, as an adequate and continuous supply of fuel is essential. The position of the coal trade is likely to be a difficult one for some time to come, especially so far as exportation is concerned, but it is hoped to be able to make a good start in January. A quick return to work would, of course, alter the outlook very appreciably, but as matters stand it is problematical whether fuel will be shipped before the end of the year. Some large exporters think it will not be, and colliery fitters, too, are not over-sanguine. Imported fuel, except on definite orders for utility companies, is likely to recede in value in proportion to the expansion of local production. Impatient at the delay in arranging a settlement, miners in both counties have gone back in large

numbers this week, and at several collieries more men have signed on than there is work for. There is an impression that if all goes well in the voting of the men in Northumberland and Durham, the two associations of owners and the miners will very soon get together and evolve a proper working arrangement.

Cleveland Iron Trade.

With the end of the coal dispute in sight, and the probability of a fall in prices of pig iron, consumers are likely to adopt a very cautious attitude during the next few weeks. Preparations are already being made to put plant into operation again, but inquiries as to when work will be resumed elicit only vague replies. Much depends on circumstances. Certainly the iron and steel industry cannot get back to normality until fuel prices are greatly reduced. Supplies, too, are bound to be scarce until the more urgent domestic and utility demands are satisfied, and therefore an indefinite period may elapse between the lighting of the blast-furnaces and the production of pig iron of a marketable quality. Moreover, most of the furnaces are owned by steel firms, which will naturally meet their own pressing requirements first, and, all things considered, there seems no prospect of any more pig iron being produced for the market this year. Hence no immediate fall in prices is looked for, but it is hinted that business may be possible over the first quarter of next year at 80s. to 85s. per ton for Cleveland foundry iron, and 90s. for East Coast hematite, but no definite transactions have been recorded. For prompt deliveries prices are unchanged, No. 1 Cleveland foundry iron being 125s.; No. 3 G.M.B., 120s.; No. 4 foundry, 119s.; and No. 4 forge, 118s. 6d. per ton. Naturally with the expectation of a falling market, buyers are only purchasing from hand to mouth, but the producers seem to be selling all their output.

Hematite Pig Iron.

It is now impossible to secure mixed numbers of East Coast hematite pig iron, and transactions in this branch are confined to odd lots of off-grades at varying figures after individual negotiations.

Ironmaking Materials.

Interest in the foreign ore trade is reviving. Many works will soon be needing supplies, but the freight position is so uncertain that it is difficult to quote a c.i.f. price, and none is mentioned on the market. The coke stringency is, of course, entirely unrelieved, and fully 70s. per ton would have to be paid by anyone needing blast-furnace coke.

Manufactured Iron and Steel.

There are a large number of inquiries circulating in the manufactured iron and steel trade, but little business is possible under present conditions. It is hinted that there may be another early advance in the official minima for steel. Be that as it may, the fact is that even for forward delivery none of the makers will accept orders at the minimum figures, and they are therefore not a reliable guide to present or prospective values. Iron ship rivets have been advanced £1 per ton to £13 15s. and iron ship castings are now £12 10s. Galvanised corrugated sheets, 24-gauge, are at a minimum of £17 10s. per ton.

The Coal Market.

Considerable animation has been shown this week on the Northern coal market. For the first time for many months fitters and merchants are taking the view that the long stagnation is at an end, and there is a very confident expression of opinion that by next week there will be a substantial return to the pits and that normal trading will quickly be resumed. Inquiries circulating this week have been for considerable quantities and for all qualities, and for shipment, both prompt and spread over some months. If the men vote for a settlement there is no doubt that for some months business in the coal trade will be brisk, and merchants anticipate that, according to grade, prices will run as a minimum at 25s. to 30s. Speculators now quote freely at 30s. for best steams and other first grade coals. The imported coal market is idle. New business is unworkable, as, owing to the more favourable outlook in home coalfields, consumers are satisfied that the quantities already booked and due to arrive over the next few weeks are ample to cover any shortage of requirements from local production.

Sheet Works Change Hands.

Arrangements are now awaiting final endorsement for the sale by Bolckow, Vaughan and Co., Ltd., Middlesbrough, to Mr. Charles H. F. Bagley, of Darlington, of the Eston Sheet and Galvanising Company's works, which are situated at South Bank, in close proximity to many huge industrial establishments. The works cover an area of seven acres and are of a modern character, having been built in 1912. When they were originally laid down four sheet mills were erected, and two more were put up in 1920. The output capacity is 600 tons per week. The works are one of the few on Tees-side which have been able to carry on and keep their workmen fully employed throughout the coal stoppage. It is understood to be the intention to float a public limited company, and that there will probably be a new issue of capital. Mr. Bagley, who has had a wide experience in the iron and steel trade on the Continent and in America, as well as in this country, is a son of Mr. J. C. Bagley, who was for many years managing director of the South Durham Steel Company, Ltd.

SCOTLAND.

(From our own Correspondent.)

The Outlook.

In view of the probably imminent settlement of the coal trade dispute, it can be said that the general trade outlook has correspondingly improved. Granted a reasonable price for fuel, the results of a settlement should be soon apparent at the shipbuilding yards and in the steel, iron and allied industries. Shipbuilding contracts which have been held up will be proceeded with, and this will have an almost immediate effect on the steel and iron industries. Prospects for some time ahead are good, and after that depend on the preservation of peace in industry. In the words of a prominent steel maker: "Much also depends on the policy followed throughout the country with regard to costs in basic trades, such as ore, transport, &c. If care is not exercised in that direction or if the new mining terms jeopardise prices, new work, I am afraid, will pass by us." After the stoppage ends there should be regular work for some months ahead at least.

Bridge Contract.

It has been announced that Sir William Arrol and Co., Ltd., Glasgow, have secured the contract for the bridge across the Yare, which has been placed by the Port and Haven Commissioners of Great Yarmouth, in conjunction with the local Corporation. The value of this contract is stated to be £200,000.

Steel and Iron.

Business in the steel and iron trades has continued quiet, pending a settlement of the coal trade dispute. The majority of the works are still idle, and will not restart until the price of fuel warrants such a proceeding. Meanwhile heavy steel is practically unprocurable, all the works being closed down. Steel sheet makers, on the other hand, are very busy, certain of the works being fully booked for some time ahead. Prices are all firm. Only two bar iron works are in operation, and at them chief attention is being given to the production of steel bars, manufactured from foreign billets. Bar iron therefore is scarce, and is quoted in the region of £12 to £12 10s. per ton for home delivery. Little or nothing is being done in pig iron, as only odd lots are available. Makers are securing high prices for any quantities sold. Foundry pig iron is nominally quoted 100s. per ton for No. 1 and 95s. for No. 3 for delivery when work is resumed at the furnaces.

Coal.

The coal market has been unsettled throughout the past week. Consumers have been observing the strictest caution in view of the expanding supplies of home fuel and the downward tendency of prices. Many collieries have cancelled contracts at the request of buyers and are now on the outlook for fresh business. Screened coal has been offered at 50s. per ton for prompt delivery, and something under that figure for delivery next week. Other collieries are insisting on the maximum price of 55s. per ton at the pit. Business has been done at 50s. to 55s. per ton for screened coal, 45s. to 47s. 6d. for triping, and 40s. to 45s. for dross at the pit. Foreign coal has been on offer at an average of 20s. per ton under last week's figures, but practically no business has been done. Household fuel is now selling round about 3s. 9d. per cwt. bag, representing a decrease of 1s. 3d. per cwt. In some districts permits are required for house coal, but merchants state that they are wholly unnecessary, in view of the abundant stocks of coal now held.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Transition Stage.

An air of expectancy has prevailed in coal trade circles during the past week. The Exchange has been more largely attended than for months past, and a spirit of optimism has replaced that of despair. Everybody is looking forward to the wheels of commerce again revolving, that is, in respect of coal export business, which is the main occupation of this district, coupled, of course, with the importation of pitwood and other mining timber. Conditions are in the transition stage. The chartering of tonnage to lift American coals for discharge in this country has practically stopped, and there are very few freights available in respect of coals from continental ports, so far as the United Kingdom is concerned. Prices of foreign coals have fallen to a marked extent. Whereas a week or so ago cargoes of American run-of-the-mine were quoted in the neighbourhood of 80s. per ton c.i.f., it has been possible to obtain supplies at rather less than 60s. per ton c.i.f. In view of the outlook as regards obtaining supplies of home-produced coals, there are practically no buyers of foreign coals. Even the prices at pit recently quoted for Welsh coals—viz., 55s. for large, 50s. for through, and 40s. for smalls—are not proving attractive to buyers, who look for a material reduction in values now that outputs are increasing. So far as export business is concerned, everything at the moment is in a state of uncertainty. Collieries are not making definite offers, but are simply indicating what they might accept, such as 35s. for the best Admiralty large, 30s. for superior second qualities and for best dry large, while smalls range up to about 25s. At the moment exporters are not experiencing a noticeable demand on the part of foreign consumers that will enable them to pay such prices plus rates of freight, which are several shillings above the figures prevailing prior to the stoppage. Two or three steamers have been chartered to load coals from this district for West Italy at 12s. 6d. and 13s. freight, with readiness within thirty days of a general resumption of work, and a couple of steamers have been taken up for Buenos Aires at 16s. 9d. and 17s. 3d. freight. In the case of the tonnage for West Italy the rates of freight compare with the rate of 9s. 6d. prevailing before the coal stoppage.

Export Restrictions.

Under the Emergency Regulations, there has been an embargo on the export of coal in the interests of home consumers, and that restriction is still in operation The question is how soon will it be lifted. It is of paramount importance to this district, as if the embargo is kept in force a moment longer than is absolutely necessary a state of chaos will be brought about. The matter has been taken up by the coalowners and the exporters, and a letter has been forwarded by the Commercial Committee of the Coalowners' Association to the Secretary of Mines pointing out that the duration of the present restrictions on the distribution of coal has become a matter of grave concern to all interested in the export trade. The point is emphasised that the conditions in the South Wales coalfield differ fundamentally from those of any other coalfield. The bulk of the output is exported. Under ordinary circumstances, the proportion of the output that is shipped as cargo and bunkers is between 60 and 70 per cent., while many collieries are entirely dependent on the export trade. The letter also sets forth the difficulties in respect of the wagon supply, and the possibility of the quantity of tonnage available being rather limited. As a consequence, it is urged that immediate consideration should be given to the withdrawal of all restrictions on the free movement of coal in South Wales. As a matter of fact, the uncertainty that is prevailing as to what supplies of coal will be available for export is already handicapping operations, since exporters are unable to form any definite idea as to the position for which they can charter tonnage.

The Coalfield Position.

Another obstacle to the resumption of business is the feeling of uncertainty that still prevails as to what is going to be the position in the coalfield here. The Government terms of settlement stipulated for an immediate resumption of work, but it is not by any means definite that such resumption will be seen in South Wales, though at the same time it can scarcely be thought that South Wales will hold out after other districts have resumed work. There are now about 24,000 men at work in this coalfield, but the Government terms have met with a varied reception in different areas in South Wales. It is difficult to know what to make of the situation when it is reported, for instance, in the Rhymney Valley that while several hundred more men have returned to work as compared with last week, yet mass meetings have passed resolutions against accepting the Government terms. Miners at Tredegar, Garw Valley, Abercynon, Oakdale, and Llanbradach have decided against the Government proposals, but the men at the Clydach Vale collieries (Cambrian), Eastern Valleys district, Llanhilleth, Blaenavon, Gairndiffaith, and Abertillery have given their decision in favour. At Treharris the rush of men to sign on was so great that the police had to step in to regulate the queue. On the whole, the feeling prevails that there will be a majority in favour of acceptance of the Government terms when the returns are all in, and that the conference of delegates from the coalfield to be held at Cardiff on Wednesday would authorise their representatives to the national conference in London on Friday of this week to vote accordingly. It is impossible, however, to feel certain about it, as although in the steam coal area the terms have met with a very mixed reception, the attitude of the men in the anthracite area has been more hostile to them, nearly a dozen lodges having voted for the rejection of them. So far as can be ascertained, the miners who are actually working have had little or no say in the matter. In any event, the view is held that next week will see considerably more men at work, particularly as the miners are realising that those who sign on first will get the jobs available, and that many men will not be wanted at all.

LATER.

At a South Wales delegate conference on Wednesday the vote on the Government terms resulted in 41,150 for acceptance and 120,150 for rejection, the majority against the terms being 79,000. The question was put to a card vote, with the result that there were 823 for acceptance and 2403 against, each vote representing fifty members. The drift back to the mines, however, continues, and on Wednesday the total number of men working was between 26,000 and 27,000.

Colliery Acquisition.

The efforts of the miners in the Merthyr district to get Lord Buckland to prevent the closing of the Hill's Plymouth collieries have met with success. This property, which has been in the hands of a receiver, has been acquired by Lord Buckland, with whom is associated in the deal Mr. W. M. Llewellyn, who owns the adjoining Cyfarthfa collieries. The purchase price is £160,000. Lord Buckland has stated that his intervention in the matter has in no way been prompted by business reasons, and he describes it as being far from what he terms a financial plum. However, it has made it possible to present Merthyr with a new lease of life. The miners played their part towards making the deal possible, as they have agreed to an eight hours' day for twelve months, no matter what may be the hours of work eventually agreed upon for South Wales generally. The Hill's Plymouth collieries employed before the stoppage about 1500 miners, and had an output of round about 1000 tons per day. At times as many as over 3000 men have been engaged at the pits. About 200 men started work at the pits on Monday night immediately following upon the completion of the deal.

Work at Docks.

There is to be an important meeting of all concerned in the coal export trade on Monday next to consider the question of the working of a night shift at the docks in South Wales. The feeling is growing that if the maximum amount of trade is to be obtained, coal trimmers and other workers should contribute to the desired end by expediting the transport and shipment of coals.

Orders for Ships.

Optimism regarding future trade is shown by the number of orders recently placed for tonnage. Sir W. R. Smith, Bart., head of St. Just and other steamship companies, has placed orders for two steamers of about 5800 tons deadweight with Clyde shipbuilders, and for two other steamers of about 9000 tons deadweight with North-East coast builders. Lord Glanely, head of W. J. Tatem, Ltd., has contracted for new cargo tonnage aggregating about 40,000 tons, and Messrs. Lambert, Barnett and Co., of Cardiff, have ordered a steamer of 7500 tons deadweight, to be built by the Burntisland Shipbuilding Company for delivery next August.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	—	—
No. 1 Foundry	‡4 15 0 to 5 0 0	—
No. 3 Foundry	‡4 10 0	—
‡ *For delivery after resumption of work at furnaces.*		
N.E. Coast—		
Hematite Mixed Nos.	*No quotation.*	
No. 1 „ „		
Cleveland—		
No. 1	6 5 0	6 5 6
Silicious Iron	6 5 0	6 5 6
No. 3 G.M.B.	6 0 0	6 0 6
No. 4 Foundry	5 19 0	5 19 6
No. 4 Forge	5 18 6	5 19 0
Mottled	5 17 6	5 18 0
White	5 17 6	5 18 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—	*(None offered.)*	
Foundry No. 3	3 5 0 to 3 10 0	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	*(None offered.)*	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	*(None offered.)*	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (*a*) / 4 18 6 (*b*) / 5 2 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 15 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	*(Prices nominal.)*	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	8 2 6	7 0 0
Sections	7 12 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	12 10 0 to 13 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 5 0 to 18 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 12 6	—
Boiler Plates	12 0 0	—
Joists	8 0 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 10 0	—
„ (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 7 6 to 8 15 0	
„ (Lancs. Boiler)	11 10 0 to 12 0 0	
Sheffield—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	8 15 0 to 9 5 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 15 0 to 18 0 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/3 to 25/3
Block Tin (cash)	313 10 0
„ (three months)	302 5 0
Copper (cash)	57 12 6
„ (three months)	58 10 0
Spanish Lead (cash)	29 5 0
„ (three months)	29 15 0
Spelter (cash)	33 16 3
„ (three months)	33 15 0
Manchester—	
Copper, Best Selected Ingots	65 5 0
„ Electrolytic	66 5 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 0
„ Condenser lb.	0 1 2½
Lead, English	31 0 0
„ Foreign	29 17 6
Spelter	33 15 0

FERRO ALLOYS.

(All prices now nominal.)

Tungsten Metal Powder	1/9½ to 1/10½ per lb.
Ferro Tungsten	1/5 per lb.
	Per Ton. Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0 — 7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0 — 7/3
„ „ 8 p.c. to 10 p.c. „	£20 15 0 — 6/6
„ „ Specially Refined	
„ „Max. 2 p.c. carbon	£37 0 0 — 12/6
„ „ „ 1 p.c. „	£43 0 0 — 15/-
„ „ „ 0·70 p.c. carbon	£54 0 0 — 17/6
„ „ „ carbon free	1/5d. per lb.
Metallic Chromium	3/- per lb.
Ferro Manganese (per ton)	£15 for home, £15 for export
„ Silicon, 45 p.c. to 50 p.c.	£10 17 6 scale 5/- per unit
„ „ 75 p.c.	£16 5 6 scale 6/- per unit
„ Vanadium	14/9 per lb.
„ Molybdenum	5/1 per lb.
„ Titanium (carbon free)	0/11½ per lb.
Nickel (per ton)	£170
Cobalt	10/- per lb.
Aluminium (per ton)	£112

FUELS.

SCOTLAND.

	(*Prices nominal.*)	Export.
Lanarkshire—		
(f.o.b. Glasgow)—	Steam	15/9
„ „	Ell	16/6
„ „	Splint	16/6 to 17/-
„ „	Trebles	15/9
„ „	Doubles	14/- to 14/6
„ „	Singles	13/9
Ayrshire—		
(f.o.b. Ports)—	Steam	16/9
„ „	Jewel	17/- to 17/6
„ „	Trebles	17/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—	Steam	12/6 to 14/9
Screened Navigation		21/-
Trebles		14/- to 15/-
Doubles		14/-
Singles		13/- to 13/6
Lothians—		
(f.o.b. Leith)—	Best Steam	14/- to 14/3
Secondary Steam		13/6
Trebles		14/6 to 14/9
Doubles		13/6
Singles		13/6

ENGLAND.

	Inland. (*Nominal, none on offer.*)
(8) N.W. Coast—	
Steams	*No quotation.*
Household	„ „
Coke	„ „
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-
Sheffield—	
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

	(*All prices nominal.*)
Cardiff—	
Steam Coals :	
Best Smokeless Large	35/- to 40/-
Second „	30/- to 35/-
Best Dry Large	30/- to 35/-
Ordinary Dry Large	30/- to 32/6
Best Black Vein Large	30/- to 35/-
Western Valley Large	30/- to 35/-
Best Eastern Valley Large	30/- to 35/-
Ordinary „ „	30/- to 35/-
Best Steam Smalls	25/- to 26/-
Ordinary „	20/- to 22/6
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	35/- to 40/-
„ „ Smalls	23/- to 25/-
No. 2 „ Large	30/- to 32/6
„ „ Through	25/- to 27/6
„ „ Smalls	20/- to 25/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	35/- to 40/-
Pitwood (ex ship)	40/- to 42/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals :	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Public Works.

THE holding up of public works of all kinds for an indefinite period is causing so much prejudice to the engineering trades that this aspect of national economy is regarded as failing to fulfil the object it had in view. When the cutting down of national expenditure reduces industrial activity to the extent it is doing at the present moment, the economy represents a considerable loss, and, as all the proposed schemes are of a productive character, the country loses the benefit of their realisation and many branches of the engineering trades are unable to find employment. It is now felt that this postponement of public works is a mistake, except in so far as it may be regarded as a temporary unavoidable expedient, and, now that Parliament is reassembling, strong pressure will be brought to bear upon the Government to provide the money necessary for at least the most urgent of the undertakings. The hydro-electric schemes stand first as offering national economies in the way of limiting the importation of coal, but it is doubtful whether a start can be made upon them under present conditions, for, apart from the huge capital involved, experience has shown that the particularly heavy capital charges are only justified under special circumstances, such as the electrification of railways or where there is a heavy local consumption of power. Nevertheless, the utilisation of hydraulic power is one of the great problems of the future. In the same way, rural electrification is considered to be an urgent factor in national prosperity, but it offers more difficulties than had been anticipated. It is certain that during the debate on the Budget estimates the Government will find it necessary to resist every attempt to secure new credits for public works, and the most that can be hoped for is that the existing suppression of all credits for carrying out the most necessary undertakings will be somewhat relaxed.

Oil Supplies.

The researches for liquid fuels are of so important a character that credits are always forthcoming for experimental and other work which gives promise of encouraging results. It is true that most of this money is supplied by the great industrial concerns all over the country. Prospecting continues in the oil-bearing territory at Gabian, in the Hérault, where, though some of the bores have been abandoned because they did not produce oil in sufficient quantities, three others are delivering more, and it is expected that the output of the district, which is now an average of 600 cubic metres—about 132,000 gallons—a month, will shortly be more than doubled. For the synthetic production of methylic alcohol good progress is being made with the works which are being constructed at Lens. It is hoped to start operations early next year, when the quantity of alcohol manufactured by the process developed by Monsieur Audibert at the laboratory at Villers-Saint-Paul will be from 1 to 1½ tons a day. If the cost of producing methylic alcohol from carbonic oxide and hydrogen is found to be low enough to make the process commercially successful, it is intended largely to increase the production. It is also hoped that the interesting experiments of Monsieur Audibert with the synthetic production of petroleum from carbonic oxide and hydrogen by means of special catalysers, at suitable temperatures, will permit eventually of an important new industry being created. In other directions also progress is being made. The Government is sending commissions to Algeria and to the African colonies to investigate the means of producing alcohol commercially from colonial produce, and in some cases experimental distilling plants are already being laid down. In a word, the French are confident that they will, at a comparatively early date, solve the entire problem of home-produced liquid fuels.

Eight Hours' Day.

The proposal to modify the legislation affecting the eight hours' working day has received strong support from the Paris Chamber of Commerce, which has adopted a resolution calling upon the Government to abolish certain labour restrictions which are stated to be largely responsible for the country's unsatisfactory economical situation. Under normal conditions labour is already so scarce that the deficit has to be made good by an organised immigration of foreign labour, the greater part of which would not be required if the French workmen were not often hindered from putting in a full eight hours' day through a too rigid interpretation of the regulations. It is true that, in a general way, there is a great laxity, but in many industries the official inspection is carried out with unnecessary rigour. There is a strong feeling that the eight hours' working day should be abolished altogether in the national interest, and nearly all the commercial and industrial bodies throughout the country have passed resolutions in favour of a drastic reform by means of which it is alone possible to increase production and develop an export trade. It is hardly likely, however, that the Government will sacrifice the principle of the eight hours' day, but the Paris Chamber of Commerce believes that the desired result will be attained by making the eight hours' working day effective, in the sense that employers should get eight hours work out of the men. This means that all time lost must be made good, and that longer working days should be permitted to compensate for holidays and for short time. The agitation is so strong in favour of a change in the labour legislation that it will certainly have to be dealt with in Parliament at an early date.

Rail Orders.

In view of the rising prices, a large amount of business in iron and steel has been transacted on export account, and the South African Railways have placed contracts to the value of £250,000 for delivery a considerable time ahead. The Egyptian Railways have given out orders in this country for 4898 tons of rails, and another order for 100,000 steel sleepers has been divided between the Aciéries de Micheville and the Etablissements de Wendel.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

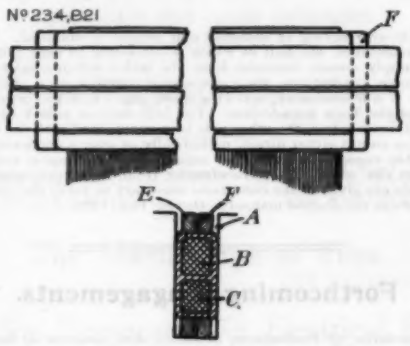
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C. at 1*s. each.*

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

234,821. May 27th, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC MACHINES WITH SLOT WINDING, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

It is well known, this specification states, that the difficulties of commutation as well as the additional eddy currents in the slot conductors of commutator machines becomes greater, the greater the inductance of the armature winding; that is to say, the greater the flux generated by the slot conductors and passing transversely through the slot. Accord-

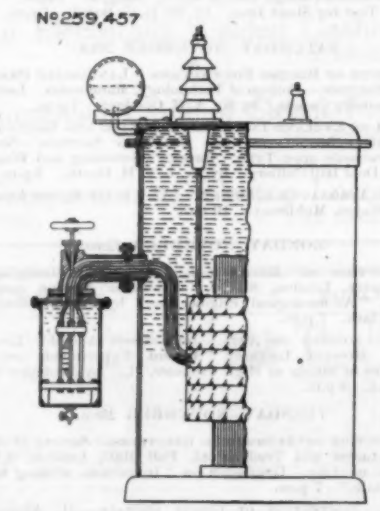


ing to this invention, the beneficial effect of damping is increased by using a damping circuit or winding. The coil is arranged with its upper and lower portions situated respectively at or near the top and bottom of the slot. The resistance of the winding is made as small as possible in order to allow the damping currents to become as strong as possible. In the drawing A is the slot and B and C two conductors. There are also two closed coils E and F, which enclose the slot leakage flux. For the purpose of reducing the resistance of these coils, they are allowed to make contact with the iron.—*September 27th*, 1926.

TRANSFORMERS AND CONVERTERS.

259,457. March 5th, 1926.—IMPROVEMENTS IN AND RELATING TO ELECTRICAL APPARATUS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

As shown in the drawing, a passageway is provided between the transformer and the tapping switch, which is immersed in oil



as are also the leads connecting the transformer windings with the switch. In most cases, the specification states, it is advantageous to provide a seal in the passageway to prevent the interchange of the insulating media between the two casings.—*October 14th*, 1926.

TELEGRAPHS AND TELEPHONES.

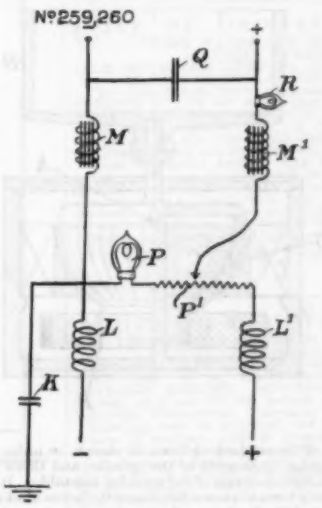
258,942. June 30th, 1925.—IMPROVEMENTS IN DIRECTIONAL AERIAL SYSTEMS FOR RADIO TRANSMISSION OR RECEPTION, Charles Samuel Franklin, of "The Clough," 39, Palmerston-road, Buckhurst Hill, Essex.

According to this invention an aerial system for the transmission or reception of wireless telegraphy and telephony comprises a number of aerials, some of which are coupled or connected directly to a transmitter or receiver or a feeding system thereof, while the other aerials are maintained in correct current phase by radiation or re-radiation from the first-mentioned aerials. Referring to the drawing, A, B, C, D and E are aerials spaced apart by approximately one half wave length. Of these B and D are aerials of the type described in the specification No. 242,342, each consisting of two, or more, sections S^1, one half wave length long, situated above one another, and connected together by coils F and G, which serve to maintain correct phase of the currents in the upper and lower sections. The aerials B D are energised from a transmission—not shown—through a feeding system F and aerial transformers T_1 and T_2. The aerials A C E are not connected directly to the transmitter, nor need they contain phasing coils between their sections S_2, but are energised by radiation from aerials B and D. If the spacing between adjacent aerials is exactly one half wave length, the separate sections S_2 will be maintained in tune. In practice, it is not necessary that the spacing between aerials be exactly one half wave length and, by small adjustments of the tune of the sections S_2 of aerials A C E, the phase of the currents induced therein from aerials B D can be controlled. It has been found that in an aerial system constructed as above described,

all the aerials can be maintained in phase, and that the system operates substantially as if all the aerials were fed directly from a transmitter. The invention is also applicable for reception of wireless telegrpahy and telephony. In this case the currents induced in aerials A C E from the received signal wave, affect by re-radiation the currents induced in the aerials B D to a degree dependent upon the direction of the origin of the received wave.—*September 30th*, 1926.

259,260. April 30th, 1925.—METHOD OF OBTAINING DIRECT-CURRENT HIGH-TENSION SUPPLY FROM DIRECT-CURRENT ELECTRIC LIGHT OR POWER MAINS, OR ALTERNATIVELY FROM SUITABLY RECTIFIED AND SMOOTHED ALTERNATING-CURRENT MAINS, George Gascoigne Blake, of Nos. 8 and 10, Onslow-road, Richmond, Surrey, and Leighton Russell-Wood, of No. 17, Thurloe Place-mews, South Kensington, S.W. 7.

The earth terminal of the wireless receiving or transmitting set is not connected to earth in the usual way, connection to

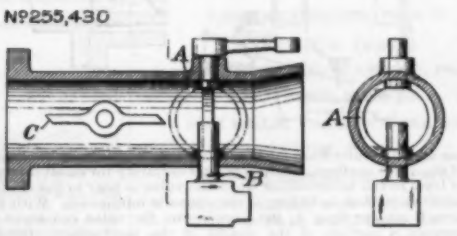


earth being provided from one or other or both of the electric light mains through a condenser K. High frequency chokes L and L^1 are placed in the mains to prevent dissipation of the received oscillations. P P^1 is a potentiometer, part of the resistance of which is formed by the lamp P. The commutator ripple is smoothed out by chokes M M^1 and a condenser Q. A small lamp R or a very fine fuse wire is provided for safety purposes. By means of another diagram, the inventors show how high-tension currents can be supplied to two or more circuits simultaneously.—*September 30th*, 1926.

MOTOR CARS AND ROAD TRAFFIC.

255,430. June 18th, 1926.—IMPROVEMENTS IN CARBURETTERS, Société Anonyme des Anciens Etablissements Panhard and Levassor, of 19, Avenue d'Ivry, Paris (Seine Department), France.

The special feature of the carburetter described in this speci-



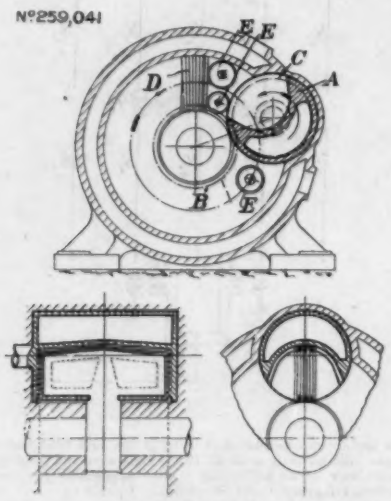
fication appears to be that a ring A is placed in the body of the carburetter and it can be rotated about the sprayer. When the ring is in the position shown in full lines on the right, the mixture contains the maximum quantity of fuel, but when the ring is turned parallel to the axis of the carburetter, the section for the air is a maximum and the mixture contains the minimum amount

of fuel, this effect being increased as a result of the fact that in this position the sprayer B is covered and is partially protected from the action of the engine suction. The butterfly valve C serves to regulate the admission of the mixture to the engine.—*October 14th*, 1926.

MISCELLANEOUS.

259,041. June 25th, 1925.—Rotary Engines, K. Bernhard, Hutweidengasse 15, Vienna XIX., Austria.

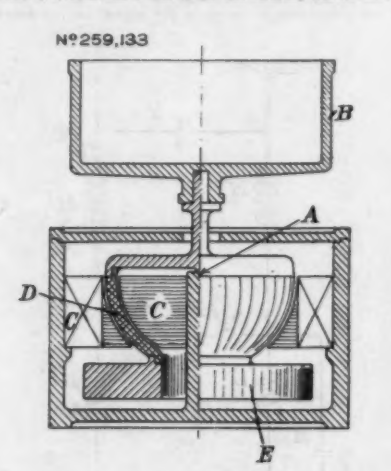
In this rotary engine the abutment A is driven from the main shaft by gear wheels B and C, and has a deep recess cut in its



face to allow the piston D to pass. This piston, for some unexplained reason, is of trapezoidal form, as shown in the cross-section and is provided with flexible packing rings. The object of the devices E E E is not explained.—*September 27th*, 1926.

259,133. April 20th, 1926.—Motors for Centrifuges, *British Enka Artificial Silk Company, Pinner's Hall, Austin Friars, London, E.C. 2.*

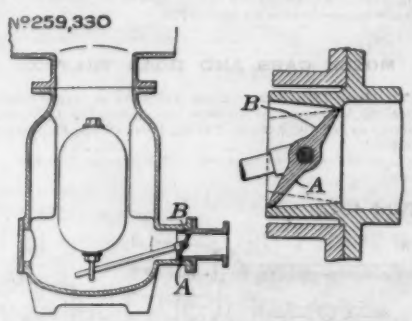
This centrifuge, or hydro-extractor, has only one bearing at A, which is of the footstep type, and allows angular movement of the spindle. The "basket" of the centrifuge is shown at B. The stator C C and the rotor D of the motor, which drive the



basket are of hemispherical form, as shown, in order to accommodate angular movement of the spindle, and there is a heavy weight E at the lower end of the rotating assembly. It is claimed that with this form of motor the magnetic forces tend to stabilise the running of the basket while the electric current is on, while the weight E serves the same purpose when the machine is at rest.—*October 7th*, 1926.

259,330. July 22nd, 1925.—Improvements in Steam Traps or Condensate Accumulators for Steam Plants, William Ernest Wyatt Millington, of 54, Imperial-buildings, Oxford-road, Manchester.

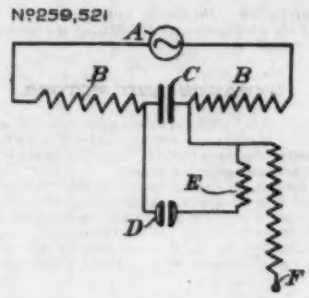
The drawing shows the invention applied to a steam trap of the float type. The butterfly or wing type discharge valve has



one area A greater than the area B, with the result that the closing of the valve is effected with a greater certainty for small changes of level in the accumulator when the valve is near to the closing position, so that dribbling at the valves is minimised. With the area B greater than A, the pressure on the valve can assist to support a portion of the weight of the mechanism.—*October 14th*, 1926.

259,521. August 11th, 1925.—Improvements in Spark-gap Oscillation Generators, Dr. Gerhard Freiherr du Prel, of 50, Barerstrasse, Munich, Bavaria, Germany.

The object of this present invention is to provide a circuit whereby, even in the case of alternating current, a large amount of alternating energy can be converted into high-frequency energy while, if the spark gap is switched off or short circuited, only a small amount of current is allowed to pass. This object is achieved by connecting across a low-voltage alternating-current source, for instance, a lighting current supply, an oscillating circuit which is only in tune with the supply frequency when the spark gap is in operation, the working condition being such that the charging voltages produced in the condenser suffice to operate the spark gap. A is the alternator. B B are the self-inductance coils which are electrically separated but magnetically combined by being wound on the same iron core. By this arrangement a



considerable saving of material and weight is obtained. The self-inductance, one-half of which is connected to each pole of the supply circuit, excludes from the latter detrimental high-frequency oscillations, the coils acting together as a choking coil. C is a condenser, and D a spark gap. E is the primary coil of the Tesla transformer. The high-tension pole F of the transformer is free, the other pole being connected with the low-tension circuit either direct, metallically or over a condenser of suitable capacity, in order to isolate the high-tension coil, or rather, the whole Tesla transformer from the supply circuit. Details are given of the conditions necessary to make the circuit operate in the desired manner.—*October 14th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Paper, "Electric Locomotives: A Method of Classifying, Analysing, and Comparing their Characteristics," by Mr. T. A. F. Stone. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Short Wave Wireless Communication," by Mr. B. J. Axten. 7.30 p.m.

West Bromwich Engineering Society.—Technical School, West Bromwich. Paper, "Steel Making and Special Steels," by Mr. F. A. Hurst. 7.30 p.m.

West of Scotland Iron and Steel Institute.—Room 24 Royal Technical College, George-street, Glasgow. Paper, "Malleability Test for Sheet Iron," by Mr. G. G. Baird. 7 p.m.

SATURDAY, NOVEMBER 20TH.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Manchester. Lecture, "The Foundry Cupola," by Mr. A. H. Goodger. 7 p.m.

North of England Institute of Mining and Mechanical Engineers: Associates' and Students' Section.—Neville Hall, Newcastle-upon-Tyne. Paper, "Screening and Washing Plant at Deaf Hill Colliery," by Mr. L. F. H. Booth. 3 p.m.

Royal Aeronautical Society.—Visit to the Fairey Aviation Works, Hayes, Middlesex. 10 a.m.

MONDAY, NOVEMBER 22ND.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Lecture, "Archæological Engineering," by Lieut.-Colonel E. Kitson Clark. 7 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Howard Lecture, "Recent Experiments on the Properties of Steam at High Pressure, II.," by Professor H. L. Callendar. 8 p.m.

TUESDAY, NOVEMBER 23RD.

Institution of Automobile Engineers.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Informal meeting. Discussion on "Inventions relating to the Automobile." 7 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "The Imperfect Crystallisation of Common Things," by Sir William Bragg. 5.15 p.m.

WEDNESDAY, NOVEMBER 24TH.

Institution of Automobile Engineers.—Birmingham Graduates visit to the works of the Lanchester Motor Company, Ltd., Montgomery-street, Birmingham. 2.30 p.m.

Institution of Automobile Engineers: North of England Centre.—The Engineers' Club, Albert-square, Manchester. Paper, "Recent Researches on Friction and Lubrication," by Mr. J. E. Southcombe. 7 p.m.

Keighley Association of Engineers.—Visit to the Hunslet Engine Works and the Engineering Section of Leeds University.

Newcomen Society.—The Science Museum, South Kensington, London, S.W. 7. Annual general meeting. Paper, "High-pressure Steam and the Work of the Perkins Family," by Mr. C. R. King. 5.45 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Industrial Welfare in Practice," by Mr. W. S. Bradley. 8 p.m.

THURSDAY, NOVEMBER 25TH.

Institution of Automobile Engineers.—Training School of Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "Lubrication," by Mr. T. T. Brown. 7.30 p.m.

Institution of Civil Engineers: Yorkshire Association.—Hotel Metropole, Leeds. Paper, "Modern Surveying Instruments," by Mr. W. H. Connell. 7.30 p.m.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Municipal Hygiene Roads and Road Making: Collection and Disposal of Refuse," by Mr H. Morley Lawson. 7 p.m.

FRIDAY, NOVEMBER 26TH.

Diesel Engine Users' Association.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Modern Air Compressor Practice in Oil Engine Installations," by Mr. R. L. Quertier. 3.30 p.m.

Institution of Electrical Engineers: South Midland Centre.—Grand Hotel, Birmingham. Annual dinner. 6.30 for 7 p.m.

Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Sackville-street, Manchester. Paper, "The Sentinel Engine," by Mr. J. W. Beaumont. 7 p.m.

Institution of Production Engineers.—Society of Motor Manufacturers and Traders' Rooms, 83, Pall Mall, London, S.W. 1. Paper, "The Application of Manufacturing Methods to Non-repetition Work," by Mr. H. C. Armitage. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Petrol and its Substitutes for Use in Internal Combustion Engines," by Colonel the Master of Sempill. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. "The Practical Analysis of Merchant Ships Trials and Service Performance," by Dr. E. V. Telfer. 6 p.m.

Tunnellers' Old Comrades Association.—Gatti's Restaurant, Strand, London, W.C. 2. Annual dinner. 7 for 7.30 p.m.

SATURDAY, NOVEMBER 27TH.

Institution of Municipal and County Engineers.—City Engineer's Office, City Hall, Cardiff. South Wales District meeting. 3 p.m.

North of England Institute of Mining and Mechanical Engineers: Associates and Students' Section.—Wood Memorial Hall, Newcastle-upon-Tyne. Social evening. 6 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "Atmospheric Electricity," by Mr. G. C. Simpson. 3 p.m.

MONDAY, NOVEMBER 29TH

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Crank Shafts," by Mr. S. Robertson. 7 p.m.

Institution of Engineers-in-Charge.—Showrooms of the Gas Light and Coke Company, Church-street, Kensington, London, W. Paper, "The Uses of Gas in Industry," by Mr. J. Ennals. 7.30 p.m.

WEDNESDAY, DECEMBER 1ST.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "The Torque Converter," by Mr. G. Constantinesco, 8 p.m.

THURSDAY, DECEMBER 2ND.

Royal Aeronautical Society.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "Valve Steels," by Mr. P. B. Henshaw. 6.30 p.m.

FRIDAY, DECEMBER 3RD.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. "Industrial Ventilation," introduced by Mr. A. E. Harris. 7 p.m.

Junior Institution of Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Presidential address, "The Progress of Marine Engineering," by Engineer Vice-Admiral Sir Robert B. Dixon. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. S. G. M. Ure has been appointed honorary editor of the "Transactions" of the Institution of Chemical Engineers. He will also be responsible for the editorial matter appearing in the *Quarterly Bulletin*.

We are asked to state that Mr. A. K. Wilson has joined the Board of the Parkgate Iron and Steel Company, Ltd., in the place of the late Mr. C. P. Markham. Mr. Wilson is governing director of Spear and Jackson, Ltd., and also a director of Joseph Rodgers and Sons, Ltd. The other directors of the company are Mr. Douglas Vickers, Sir Wm. B. Bird, Mr. A. Willis Dixon, and Mr. P. W. Fawcett.

Messrs. Walter Dixon and Co., of 38, Bath-street, Glasgow, C. 2, ask us to announce that the practice of consulting engineers carried on by them with the late Mr. Walter Dixon and Mr. Frank Anslow as principals is being continued under the firm name of Walter Dixon and Co., the partners being:—Frank Anslow, M.I.E.E., M. Cons. E., &c.; and Arthur Dixon, B.Sc., A.R.T.C., &c., son of the late Mr. Walter Dixon.

Steel Castings.—That designers should consult steel founders before sending out drawings of machine parts that were to be cast in steel was a point emphasised by Mr. Robert Lowe in a lecture on the subject of "Steel Castings in their Relation to Mechanical Engineering," at a meeting of the Junior Institution of Engineers on November 5th. Mr. Lowe said that trouble and expense could be saved by collaboration between the designer and founder on such points as method of construction, placing of cored holes, and position of machined surfaces. The principal art in steel foundry work lay in making the casting most sound at the most important places. With a knowledge of the use to which a casting was to be put and the work to which it would have to stand up, the steel founder would arrange the number and position of his feeders and risers in the appropriate manner, and the result would be a casting suited to its job. To ensure soundness in articles such as gear wheels, it was a common practice to waste 100 per cent. of material in the form of risers. Mr. Lowe said that steel founders were trying hard to find some kind of test which would afford some guarantee that steel castings would not disclose defects after a period of working. Existing tests, whether hydraulic, steam or air, did not do all that was desired, because they did not always detect incipient flaws.